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naturelles et en génie du Canada

200, rue Kent
Ottawa, Canada
K1A 1H5

STRATEGIC GRANTS IN COMMUNICATIONS AND COMPUTERS

LES SUBVENTIONS THÉMATIQUES EN TÉLÉCOMMUNICATIONS ET INFORMATIQUE

- Summaries of New Research Projects
  Résumés des nouveaux projets de recherche

- List of On-going Research Projects
  Liste des projets de recherche en cours

- Summaries of Completed Research Projects
  Travaux de recherche terminés

1986 - 1987

Canada

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FOREWORD / AVANT-PROPOS

FOREWORD

The Natural Sciences and Engineering Research Council offers a program of strategic grants to initiate or accelerate research projects in areas of Canadian interest. The aim of the program is to enable university researchers to make greater contributions than in the past towards the understanding or solution of problems of national concern, either through specific applied research projects having potential for relatively short-term benefits, or through more basic research activities designed to develop knowledge in areas of potential importance. The total budget for the strategic grants program for 1986-87 is $32 million.

In 1986-87 the strategic grants program addressed eight specific fields: 1) biotechnology, 2) communications and computers, 3) energy, 4) environmental toxicology, 5) food and agriculture, 6) industrial materials and processes, 7) oceans, and 8) open (which includes areas of national concern other than the seven identified fields).

Selection panels composed of recognized scientists and engineers from the university, industry and government sectors rate all proposals using the following criteria:

- scientific merit of the proposed research;
- excellence of the applicant(s);
- relevance of the proposed research to the field.

AVANT-PROPOS

Le Conseil de recherches en sciences naturelles et en génie offre un programme de subventions thématiques visant à lancer ou à accélérer des projets de recherche dans des domaines d'intérêt national. Le but de ces subventions est de permettre aux chercheurs universitaires de contribuer davantage à la compréhension et à la solution de problèmes d'intérêt national. Il peut s'agir de recherche appliquée pouvant s'avérer utile à court terme ou encore de recherche plus fondamentale destinée à augmenter la somme des connaissances dans des domaines d'intérêt national. Le budget total du programme en 1986-1987 est de 32 millions de dollars.

En 1986-1987, le programme de subventions thématiques comprenait huit domaines choisis: 1) l'alimentation et l'agriculture, 2) la biotechnologie, 3) l'énergie, 4) les matériaux et procédés industriels, 5) les océans, 6) le thème "ouvert" (regroupant des domaines d'intérêt national autres que les sept domaines choisis), 7) les télécommunications et l'informatique et enfin, 8) la toxicologie de l'environnement.

Des comités de sélection composés de scientifiques et d'ingénieurs reconnus provenant des secteurs universitaire, industriel et gouvernemental utilisent les critères suivants pour évaluer toutes les demandes:

- valeur scientifique de la recherche proposée;
- excellence des candidats;
- pertinence du projet par rapport au domaine désigné.

Each criterion carries equal weight. To be funded, an application must receive a high ranking under each of the three criteria. Regional considerations do not enter into the evaluation of proposals submitted under this program. The panels are responsible for deciding what is relevant to, and of priority within, the broad areas identified for support, consistent with the descriptions of the fields.

Les comités doivent accorder une importance égale à chacun des critères. Pour obtenir une subvention, le projet doit recevoir une cote élevée en fonction de chacun des trois critères. Les considérations régionales ne doivent pas entrer en ligne de compte dans l'examen des demandes. Les comités ont la responsabilité de déterminer la pertinence des divers secteurs et leur priorité à l'intérieur de chaque domaine désigné, en se basant sur les descriptions des domaines.

The strategic grants program contributes to the training of research manpower and encourages the transfer of technology to the user sector. This is the basis of its success. To facilitate this technology transfer, NSERC annually publishes booklets describing some of the research funded through the program. There is a separate booklet for each field; each one contains summaries of the new research projects funded as a result of the annual strategic grants competition, a list of all on-going projects funded by NSERC in the particular field, and summaries of strategic research projects completed in 1986, including references to publications arising from the NSERC-funded research. Further information on the research being supported by NSERC may be obtained by contacting the researcher directly, or the Strategic Grants Division at (613) 996-1597.

Le programme de subventions thématiques contribue à former des chercheurs et donne lieu à un transfert de technologie au secteur des utilisateurs: voilà la base de son succès. Afin de faciliter le transfert de technologie, le CRSNG publie, chaque année, des livrets décrivant la recherche subventionnée dans le cadre de ce programme. Chaque domaine fait l'objet d'un livret séparé; on y retrouve un résumé des nouveaux projets de recherche subventionnés suite au concours annuel de subventions thématiques, une liste de tous les projets en cours dans le domaine en question subventionnés par le CRSNG et un résumé des projets de recherche thématique terminés en 1986, y compris des références aux publications découlant de la recherche subventionnée par le CRSNG. Des renseignements supplémentaires sur les projets de recherche appuyés par le Conseil peuvent être obtenus en communiquant avec le chercheur lui-même ou avec la division des subventions thématiques au (613) 996-1597.

NSERC offers other opportunities for technology transfer under its university/industry program. Further information on this program or on any of NSERC's awards programs may be obtained by calling (613) 995-5992 or by writing:

Le CRSNG offre d'autres possibilités pour le transfert technologique grâce à son programme conjoint universités-industrie. Pour plus d'information sur ce programme ou sur les autres programmes du CRSNG, veuillez téléphoner au (613) 995-5992 ou vous adresser au:

NSERC
Communications Division
200 Kent Street
Ottawa, Ontario
K1A 1H5

CRSNG
Division des communications
200, rue Kent
Ottawa (Ontario)
K1A 1H5

FIELD DESCRIPTION / DESCRIPTION DU DOMAINE

COMMUNICATIONS AND COMPUTERS

Canada's unique geographical and demographic situation, and its abundance of natural resources gives rise to special problems and opportunities in Communications and Computers. This field encompasses the conceptual, electrical and physical aspects of collecting, organizing, moving, storing, manipulating, presenting and using information.

Underlying needs for communications and computers research and development in Canada relate to:

a) development of the technologies and capabilities needed to be internationally competitive;

b) application of the new technologies and capabilities to resource based activities;

c) use of communications and computers to replace physical transport;

d) equalization of services between urban and rural areas.

The following are examples of areas of study. This list is by no means exhaustive.

1. Components, Devices and Materials

- Microelectronics
- High and low power devices
- High reliability components
- Optical and opto-electronic devices
- Millimetre and microwave components
- Sensors and transducers

2. Transmission

- Media characteristics
- Fixed and mobile equipment
- Satellite technology
- Spectrum utilization and allocation
- Error control

3. Networks

- Voice, video, data and computer networks
- Switching, multiplexing, flow control
- Protocols

TÉLÉCOMMUNICATIONS ET L'INFORMATIQUE

La situation géographique et démographique du Canada et l'abondance de ressources naturelles crèent des occasions et des problèmes spéciaux en télécommunications et en informatique. Ce domaine englobe les aspects conceptuels, électriques et physiques de la cueillette, de l'organisation, de la transmission, du stockage, de la manipulation, de la présentation et de l'utilisation des informations.

Au Canada, on a surtout besoin de recherche et de développement portant sur:

a) le développement des technologies et des capacités nécessaire pour être compétitif sur la scène internationale;

b) l'application des nouvelles technologies et capacités aux activités basées sur les ressources;

c) l'utilisation des télécommunications et des ordinateurs pour remplacer les déplacements physiques;

d) l'égalisation des services offerts aux milieux urbains et ruraux.

Voici des exemples de sujets d'étude. Cette liste n'est pas complète.

1. Composants, dispositifs et matériaux

- La micro-électronique
- Les dispositifs de haute ou de faible puissance
- Les composants de grande fiabilité
- Les dispositifs optiques et opto-électroniques
- Les composants millimétriques et micro-ondes
- Les détecteurs et les transducteurs

2. Transmission

- Les caractéristiques des médias
- Les installations fixes et mobiles
- La technologie des satellites
- L'utilisation et l'attribution des fréquences du spectre électromagnétique
- Le contrôle des erreurs

3. Réseaux

- Les réseaux de transmission de la voix, des images et des données et les réseaux d'ordinateurs
- La commutation, le multiplexage, le contrôle de la circulation
- Les protocoles

4. Terminals and Communication Interfaces

- Input and output devices
- Software and hardware interfaces
- Storage, display and manipulation techniques
- Workstations
- Ergonometrics

5. Artificial Intelligence

- Expert systems
- Knowledge representation
- Robotics
- Computational vision
- Logic programming
- Natural language translation and speech understanding

6. General Techniques for Information Technology

- Software engineering
- Signal and image processing
- Pattern recognition
- Reliability analysis and testability
- Modulation and encoding
- Simulation and modelling
- Optimization and control

7. Systems

- Computer-based design systems (e.g. VLSI, CAD/CAM)
- Sensor-based systems
- Microelectronics-based systems
- Digital system architectures
- Distributed and parallel processing systems
- Fault tolerant systems
- Testing methodology
- Systems design methodology

Proposals with the following characteristics are encouraged:

a) cohesive group efforts and multidisciplinary approaches;
b) indications of strong links to users and industry;
c) potentially high-risk projects with clear long-term benefits.

It is important to note that applicants must clearly and realistically state objectives, milestones and deliverables, methodology, relevance, personnel training, and means of technology transfer to users and industry.

4. Terminaux et interfaces de télécommunication

- Les dispositifs d'entrée et de sortie des données
- Les interfaces de logiciel et de matériel
- Les techniques de stockage, d'affichage et de manipulation de l'information
- Les postes de travail
- L'ergonométrie

5. L'intelligence artificielle

- Les systèmes experts
- La représentation des connaissances
- Le robotique
- La vision par ordinateur
- La programmation logique
- La traduction des langues naturelles et la compréhension du discours

6. Les techniques générales en technologie de l'information

- L'ingénierie du logiciel
- Le traitement des signaux et des images
- La reconnaissance des formes
- L'analyse de fiabilité et la testabilité
- La modulation et l'encodage
- La simulation et la modélisation
- L'optimisation et le contrôle

7. Systèmes

- Les systèmes de conception par ordinateur (p. ex. VLSI, CAO/FAO)
- Les systèmes basés sur les détecteurs
- Les systèmes basés sur les dispositifs micro-électroniques
- Les architectures de systèmes numériques
- Les systèmes de traitement réparti et parallèle
- Les systèmes peu affectés par les erreurs
- La méthodologie d'essais
- La méthodologie de conception des systèmes

On encourage les chercheurs à soumettre des demandes mettant en évidence:

a) des efforts d'équipe cohérents et des méthodes multidisciplinaires;
b) des liens bien établis avec les utilisateurs et le secteur industriel;
c) des projets pouvant être risqués mais comportant des retombées à long terme.

On doit noter qu'il faut présenter d'une façon claire et réaliste les objectifs, les étapes et les résultats prévus, la méthodologie, la pertinence, la formation de chercheurs et la façon dont s'effectuera le transfert de technologie à l'industrie et au secteur des utilisateurs.

LIST OF NEW PROJECTS / LISTE DES NOUVEAUX PROJETS

Name/Nom Department/Département University/Université	Title/Titre	$*	Page
1. General Techniques for Information Technology / Les techniques générales en technologie de l'information			
Baltes, H.P. Electrical Eng. Alberta	Integrated sensors on silicon * with M.J. Brett, D.J. Harrison, L. Ristic (Alberta)	180,000	18
Delisle, G.Y. Génie électrique Laval	Calcul et mesure de sections efficaces radar * avec M. Lecours (Laval)	169,520	23
Fortier, M. INRS-Télécomm. Québec - INRS	A real-time image and video signal processing facility * with E. Dubois (INRS), S. Sabri (BNR)	162,480	27
Morissette, S. Génie électrique Sherbrooke	Algorithmes de codage numérique du signal audio de haute qualité * avec P. Mabilleau, J. Soumagne (Sherbrooke)	87,080	34
2. Terminals and Communication Interfaces / Terminaux et interfaces de télécommunication			
Dillon, R.F. Psychology Carleton	Cognitive factors in the design of human-computer interfaces: Window management, direct manipulation and design methodology * with J.W. Tombaugh (Carleton)	150,670	24
3. Networks / Réseaux			
Falconer, D.D. Sys. $ Comp. Eng. Carleton	Monolithic design of transmission devices for subscriber access in ISDN * with C.H. Chan, M.A. Copeland, T.A. Kwasniewski, S.A. Mahmoud (Carleton)	100,000	26
4. Components, Devices and Materials / Composants, dispositifs et matériaux			
Currie, J.F. Eng. Physics Polytechnique	Implementation of hybrid and LSI-integrated linear optical modulator systems for optical communication signal processing on III-V semiconductors * with R. Maciejko (École Poly.)	311,000	21
Tremblay, R. Physique Laval	All-optical waveguiding bistable device formed in semiconductor-doped glass * avec C. Delisle (Laval)	108,000	38
Yip, G.L. Electrical Eng. McGill	Integrated optics for optical communications	145,452	39

*Total funds committed / Montant total accordé

Name/Nom Department/Département University/Université	Title/Titre	$*	Page
5. Systems / Systèmes			
Agarwal, V.K. Electrical Eng. McGill	Testing and design of large area VLSI systems * with A. Alhelwani, D. Avis, J. Rajski, N.C. Rumin (McGill), Y. Savaria (École Poly.)	555,000	17
Birtwistle, G.M. Computer Science Calgary	Specification driven design * with J. Kendall (Calgary)	378,000	19
D'Eleuterio, G.M.T. Aerospace Studies Toronto	Control of flexible manipulator systems for space applications	106,103	22
Elmasry, M.I. Electrical Eng. Waterloo	Structured hierarchical design and simulation of VLSI systems * with J.A. Barby, P. Dasiewicz, J.V. Hanson, W.M. Loucks, F. Mavaddat, R.E. Sebiora, J. Vlach (Waterloo)	405,000	25
Hughes, P.C. Aerospace Studies Toronto	Control systems for large flexible spacecraft	121,680	30
Salama, C.A.T. Electrical Eng. Toronto	Micron and submicron integrated circuit design for telecommunications applications	183,000	35
6. Transmission / Transmission			
Haccoun, D. Génie électrique École Polytechnique	Étude et réalisation de codeurs et décodeurs à haute vitesse pour codes convolutionnels * avec Y. Savaria, C. Akyel (École Polytechnique)	220,860	29
McLane, P.J. Electrical Eng. Queen's	Bandwidth efficient modulation and coding for mobile satellite communications * with P.H. Wittke (Queen's)	119,400	33
Shafai, L. Electrical Eng. Manitoba	Antenna development for land mobile satellite communication * with E. Bridges (Manitoba)	250,000	36

*Total funds committed / Montant total accordé

Name/Nom Department/Département University/Université	Title/Titre	$*	Page
7. Artificial Intelligence / L'intelligence artificielle			
Cercone, N. Computer Science Simon Fraser	Accessing information through ordinary language * with W.S. Luk (SFU)	326,140	20
Frasson, C. Infor. & rech opér. Montréal	Systèmes intégrés et intelligent pour l'enseignement assisté par ordinateur * avec G. Bochmann, J. Gecsei, H. Stolovitch (Montréal), M. Kaltenback (Bishop's), G. Gauthier, A. Ouellet, R. Tremblay (UQAC), J. Fugére (CMRC), R. Hart (Victoria)	255,000	28
Lennig, M. INRS-Télécomm. Québec - INRS	Very large vocabulary speech recognition * with P. Mermelstein, D. O'Shaughnessy (INRS)	271,000	31
Levine, M.D. Electrical Eng. McGill	Range understanding for robotics * with A.S. Malowany, V. Hayward, S.W. Zucker (McGill)	281,142	32
Suen, C.Y. Computer Science Concordia	Optical character recognition algorithms and architectures * with H.F. Li, R. Jayakumar (Concordia)	210,000	37

*Total funds committed / Montant total accordé

SUMMARIES OF NEW PROJECTS / RÉSUMÉS DES NOUVEAUX PROJETS

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☒ Communications and Computers / Telecommunications et informatique	☐ Energy / Energie	☐ Environmental Toxicology / Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☐ Industrial Materials and Processes / Materiaux et procedés industriels	☐ Oceans / Oceans	☐ Open / Ouvert

Name/Nom: Professor V.K. Agarwal

Department/Département: Electrical Engineering

University/Université: McGill

Phone number (optional) N° de téléphone (facultatif): (514) 392-4286

Title of Project/Titre du projet: The Testing and Design of Large Area VLSI Systems

Although the complexity of vary large scale integrated (VLSI) circuits is still increasing as the integrated circuit (IC) technology yields ever smaller feature sizes, there is a growing interest in exploiting the design possibilities presented by larger area ICs. The objective in that case is to integrate on one IC a large number of processors, thereby improving the performance, reliability and cost of the resulting system. Such large area VLSI systems are designed by methods which are in some ways similar to those in current use. The main difference is that in the large area device, each processor is likely to have a complexity approaching that of today's VLSI IC. A simple yield analysis shows that, before large area systems become economical, some important problems related to the testing and subsequent reconfiguration of the processors into a working system will have to be solved.

The members of McGill's VLSI Design Laboratory will apply their expertise in the testing and design of VLSI systems, acquired with the help of the previous NSERC Strategic Grant, to the following subjects:

TESTING. One of the main subjects will be built-in self-test (BIST) which is emerging as an important alternative to more conventional methods of testing in wide use today. Since BIST is an off-line technique, research on problems related to on-line diagnosis and testing is also crucial to achieving reliable large area systems through reconfiguration.

COMPUTER-AIDED DESIGN (CAD). The major emphasis will be on the special problems which the reconfigurable nature of the large area system presents to the placement and routing design tools.

CLOCKING. Large area systems may be difficult to design using conventional global clocking schemes because of the inevitable delay-related clock skew problem, and research will be on self-timing as an alternative approach.

LARGE AREA IC DESIGN. Critical problems related to the design of fault-tolerant power, clock, data and control buses will be the subject of this work.

DESIGN VERIFICATION. The objective is to replace circuit simulation with a system that will use powerful algorithms to determine critical paths, specify clock characteristics and identify electrical design errors.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

- ☐ Biotechnology / Biotechnologie
- ☒ Communications and Computers / Télécommunications et informatique
- ☐ Energy / Énergie
- ☐ Environmental Toxicology/ Toxicologie de l'environnement
- ☐ Food-Agriculture / Alimentation-Agriculture
- ☐ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: H. P. Baltes

Department/Département: Electrical Engineering

University/Université: of Alberta

Phone number (optional)/N° de téléphone (facultatif): (403) 432-5871

Title of Project/Titre du projet: Integrated Sensors on Silicon

Sensors are devices that convert a mechanical, thermal, magnetic, chemical, or radiation signal into an electronic signal. Sensors are required to provide computers with input signals. Sensors link the world of analog physical and chemical data to the world of digital signal processing. As computers are increasingly employed as the controllers of instruments, vehicles, appliances, robots, and manufacturing equipment, computer compatible sensors are becoming a crucial component. The key to the development of advanced sensors is the exploitation of silicon integrated circuit technology: integrated silicon sensors that include support and signal conditioning circuitry are increasingly developed for a variety of applications and are interfaced with the rapidly proliferating microprocessor. The project addresses the development of magnetic and chemical sensors based on silicon chip manufacturing technology offered to universities by Northern Telecom through the Canadian Microelectronics Corporation. Research activities involve the design and test of novel sensor elements, the design of analog integrated circuits for sensor signal conditioning, numerical modeling of the sensor operation, and development of specific sensor fabrication technologies such as deposition of thin films.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☒ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology/ Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☐ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: G. Birtwistle

Department/Département: Computer Science

University/Université: The University of Calgary

Phone number (optional)/N° de téléphone (facultatif): (403) 220-6015

Title of Project/Titre du projet: Specification Driven Design

SUMMARY

Hardware verification is a technique by which chip designs may be proven to meet a specification of their intended behaviour. Currently, chip designs are validated by intensive simulation at several levels. The process is so time consuming that it cannot be done exhaustively for large designs. This inevitably results in designs which are flawed. Many systems can tolerate minor flaws but there are systems even now which cannot.

Obvious examples to cite are flight control, medical life-support chips (pacemakers), and military applications. The problems are of such magnitude in certain defence applications that the UK Ministry of Defence feels it cannot rely on commercial chips and has embarked on a program of producing formally verified chips to its own specification. Another class of applications for specification driven design is provided by industry where chips are used by the million, not all from the same source. The cost of a flawed design may mean the recall of many thousands of automobiles. Again it would be tremendously expensive to replace sensor chips installed on pipelines should the design be faulty. A third application area is product redesign. Technology advances mean that chips have to be reworked into a new technology every two or three years, or even less. If a design has a proven specification tree, redesign will usually mean taking and changing the lower tree nodes. There can be no change to the overall chip specification when the behaviours of the replacement designs conform to the previous specifications. In this case, the new designs can be plugged into existing systems with a guarantee that they will not introduce new bugs.

Over the last five years we have seen the development of theories and models for hardware verification, particularly by Gordon and Moszkowski. They have laid the theoretical foundation. What we intend to do in this project is develop the theory into a practical method, and develop a chrestomathy of behavioural specifications. As a vehicle for this investigation of the specification driven design methodology, we will design, specify, fabricate, and test a substantial VLSI design. The research will develop expertise in: writing and composing specifications, interfacing a specification language to existing tools to narrow the specification to chip layout gap, architectures for functional programming machines, and in sub-system development. Project deliverables will be the existence of a substantial proven correct Canadian VLSI design, a chrestomathy of circuit, sub-system, and floorplan behavioural specifications, ideas for a specification driven design VLSI CAD system and insight into how to build one to industrial standards.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

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- ☐ Food-Agriculture / Alimentation-Agriculture
- ☐ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: Dr. Nick Cercone

Department/Département: School of Computing Science

University/Université: Simon Fraser University

Phone number (optional)/N° de téléphone (facultatif): (604) 291-3791

Title of Project/Titre du projet: Access Information Through Ordinary Language

We investigate problems of constructing sophisticated natural language interfaces to commercially available relational databases, such as IBM's DB2. Such systems should access knowledge in a knowledge base rather than simply data in a database to be truly sophisticated and useful to decision makers. With the knowledge of the application incorporated into the database, the proposed system is capable of interpreting queries in ordinary language and producing not only answers directly to the queries, but also other relevant information the user may want but has not asked because of lack of knowledge of the database. The user and the system should be able to interact naturally, following dialogue principles which underly human discourse. This system is quite different from so-called natural language front-end which merely translates the natural language into a database query. The lack of sophistication, high price tag and the lack of portability have not thus far successfully persuaded users to abandon rigid but familiar database query languages in favor of ordinary language. This situation will persist unless a new generation of natural language interfaces such as this proposed is available in the marketplace.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
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- ☐ Food-Agriculture / Alimentation-Agriculture
- ☐ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: John F. Currie

Department/Département: Engineering Physics

University/Université: Ecole Polytechnique

Phone number (optional) / Nº de téléphone (facultatif):

Title of Project/Titre du projet: Implementation of Hybrid and LSI -Integrated Linear Optical Modulator Systems for Optical Communication and Signal Processing on III - V Semiconductor

Recently reported loss figures on GaAs heterostructure optical waveguides indicate that optical modulators on GaAs are very promising. Moreover, combined with the rapidly evolving technology of LSI and microwave power circuitry on GaAs, this new advance makes integrated optoelectronic systems a strategic technological development in high-speed optical communication and optical signal processing.

The prototype system we shall study consists of a ribguided double heterostructure III-V laser with a luminosity-stabilised current source, butt coupled to an optoelectronic modulator with monolithic buffer and fast (3GHz) electrical access and driving circuitry. At the conclusion of this three -year strategic program we plan to have integrated on GaAs all the above elements except the laser diode.

We shall achieve this goal in three one-year steps as follows: First, we shall concentrate on the realisation of the hybrid linear optical modulator system capable of low-loss, high speed operation. We shall use the novel Linear Modal Confinement Modulator which we have designed for GaAs. Second, we shall fabricate the appropriate access electrical circuitry on GaAs using LSI and microwave design rules which we are currently refining at Ecole Polytechnique. Finally, we shall examine the critical fabrication requirements for a process allowing integration on one chip of a laser, LSI and microwave circuitry and optical waveguide modulators. Canada needs to develop these technologies to be internationally competitive in high speed computing and communication.

The importance of this activity is two-fold. First, it will constitute significant progress in the technology of optical modulators and optical communications. Second, it will demonstrate at an early stage the worth of Ga As as a substrate for integrated optics.It is very important to examine the compatibility of realizing such a modulator, transistors and a laser diode on the same semiconductor substrate when apparently conflicting requirements come into play. Our results will help determine whether Ga As will ever become viable for integrated optics.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Telecommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology / Toxicologie de l'environnement
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Name/Nom: G. M. T. D'Eleuterio

Department/Département: Institute for Aerospace Studies

University/Université: University of Toronto

Phone number (optional)/Nº de téléphone (facultatif):

Title of Project/Titre du projet: Control of Flexible Manipulator Systems for Space Applications

Canada's main thrust in space technology research for at least the next 15 years will be in the area of remote manipulator systems. This was confirmed by the Canadian government decision in March 1986 to allocate $800M to the development of a mobile servicing center for Space Station. Canada has thus made a major commitment to participate in the next evolutionary phase of robotics.

The principal objective of this research project is the control of flexible manipulator systems for space applications. The new generation of 'space cranes' required for the Space Station will, by necessity, be flexible to the extent that flexibility will be one of the most important characteristics. As a result, new methods of dynamical analysis and new methods of control will be warranted.

This project will seek to develop improved computer simulation models for flexible manipulators. A general investigation will also be undertaken into new techniques which could provide effective control and specific control algorithms will be devised.

In addition to the theoretical work, an experiment will be conducted to verify the models and test and evaluate the various control algorithms. The experimental set-up will consist of a two-link flexible manipulator (with two actively controlled rotational joints) resting on an air table.

It is anticipated that this research project will make significant contributions to the field of robotics, in general, and the area of space manipulators, in particular.

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Name/Nom: DELISLE, Gilles Y.

Department/Département: Génie électrique

University/Université: Laval

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Title of Project/Titre du projet: Calcul et mesure de sections efficaces radar

Ce projet a pour objet l'élaboration de techniques analytiques permettant la prédiction des sections efficaces radar de cibles complexes. Il est en effet très important de connaître ces paramètres lors de la conception, de la vérification et de l'évaluation des performances de divers systèmes radar.

Le projet présente également un aspect expérimental important car, en plus de la vérification des résultats obtenus analytiquement, il vise à permettre l'introduction des paramètres balistiques des cibles ou projectiles dans les techniques de mesure, cela en vue d'utiliser les résultats pour l'identification et la reconnaissance d'objets à l'aide d'un radar.

Globalement, le projet fait appel à un ensemble de techniques électromagnétiques de très haut niveau pour obtenir les résultats espérés et réaliser les manipulations expérimentales qui s'effectuent dans une bande de fréquence très large, typiquement entre 1 et 40 GHz.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

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- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: R.F. Dillon

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University/Université: Carleton

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Title of Project/Titre du projet: Cognitive factors in the design of human-computer interfaces.

The ultimate goal of this research is to make complex computers easy to use. This can only be accomplished by taking the cognitive abilities and limitations of users into account when designing the interface between humans and computers. The first objective is to provide cognitively based design guidelines in three areas: window management, performing commands by direct manipulation, and organizing computer tasks as integrated projects.

A window is an area of a computer display associated with a task being performed on the computer. More than one window (or task) may be available at one time. We will formulate guidelines for the effective use of windows. Direct manipulation is the best method to give commands to computers. For example, rather than typing the word "editor", you might use a pointing device to touch a picture or representation of the editor in the computer display. How the use of direct manipulation can be better incorporated into useable interface designs will be studied. Tasks on a computer are typically organized as a set of unrelated "tools" -- a word processor, a drawing program, a statistics package. We will attempt to organize and integrate the tools into meaningful projects.

To determine guidelines, a four stage methodology will be used: (1) Task analysis and (2) cognitive analysis and identification of relevant cognitive theories will result in (3), the identification of design alternatives. These alternatives will then be subjected to (4) iterative user testing, cognitive analysis and, finally, formal experimental comparison. The result will be principles which will be of benefit to computer system designers.

The second goal is to formalize and describe the design methodology. By following this approach, we will not only develop needed guidelines on window management, direct manipulation and integrated projects, but also develop and demonstrate a general design approach applicable to any computer-human interface design effort.

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- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name Nom: M.I. Elmasry

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University/Université: University of Waterloo

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Title of Project/Titre du projet: Structured hierarchical design and simulation of VLSI systems.

The complexity of microchips has grown at a tremendous rate over the last twenty years. This is referred to as Very-Large-Scale-Integration; VLSI for short. VLSI signifies the high technology area where it is possible for a yesteryear room-size computer to be implemented on todays silicon chips, the size of a pin head. However, the rate of using this technology would decrease because the required man-years is, today, uneconomically high. This situation can be altered by adapting efficient design and simulation techniques. This is a must in order to take full advantage of the VLSI technology.

The research objective of this project is to examine new methods to design and simulate complete VLSI systems efficiently, economically and reliably. The project is in its second three year period and has enjoyed the support and interaction of Canadian industry.

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Name/Nom: David D. Falconer

Department/Département: Systems and Computer Engineering

University/Université: Carleton University

Phone number (optional) N° de telephone (facultatif) (613) 564-3892

Title of Project/Titre du projet: Monolithic Design of Transmission Devices for Subscriber Access in ISDN

Following years of discussion and debate, the world's telecommunications manufacturers and operating companies are reaching consensus on defining a standard for an Integrated Services Digital Network (ISDN). The major impetus behind ISDN is the demand for new services. The proliferation of computers in industry government, education institutions, and in our homes is resulting in increasing demands on data transmission capability and the need to improve the management of information. To meet these demands, the telecommunications network must become more flexible, reliable and capable of providing cost-effectively capacity and services where and when they are needed. ISDN promises to provide a unified access to the subscribers for the transmission of voice, data and facsimile messages as well as future video transmission capability.

The basic features and services of ISDN will be provided to customers by means of a bi-directional 160 kilobit per second digital signal transmitted over existing twisted-pair telephone subscriber loops. For the successful market penetration of ISDN, it is essential that satisfactory transmission performance be achieved over close to 100% of all existing loops, including those loops which have severe problems of attenuation, distortion and noise. It is also essential for reasons of cost that the digital transmission function be carried out with low cost VLSI devices.

The research proposed here is aimed at improving the range and performance (and increasing the bit rate, in possible future enhancements) of the basic ISDN access by means of coding techniques and also by means of novel analog-to-digital conversion techniques with all-digital signal processing. We will also investigate realization of these techniques with VLSI design and simulation tools.

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Name/Nom: *M. Fortier. E. Dubois. S. Sabri*

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University/Université: Université du Québec

Phone number (optional)/N° de téléphone (facultatif): (514) 765-7822

Title of Project/Titre du projet: **A real-time image and video signal processing facility**

Over the past years. a great deal of attention has been focused on image and video signal processing algorithms as well as their implementations. Technological advances have brought forward increasingly more powerful and cost-effective devices into this field which has further stimulated the ongoing efforts using more complex and also new functions. Trends to produce higher quality television systems have been felt through the proposal of systems like MAC. HDTV. digital component signals in the studio and digital processing in the transmitters and receivers. e.g.. multidimensional filtering. Moreover. there is a very keen interest by Canadian euipment manufacturers to use digital technology to be competitive. Two classes of methods exist to investigate these algorithms: a) simulation and b) real-time implementations. Simulation systems allow a great deal of flexibility but are constrained by processing times and length of recorded sequences. On the other hand. real-time implementations eliminate these problems but introduce difficulties at the level of system flexibility. Generally. however. the algorithm is applied to the video signal after having been properly formatted. e.g.. component format. before multiplexing to NTSC or after demultiplexing (at the home receiver). forinstance) and before display. Hence. a common framework can be designed and is the objective of this project. To this facility. other subsystems can be later attached which could then use well adapted architectures to the functions involved and can benefit from newly developed integrated circuits. This common framework would give the added advantage of shortening prototype design experiments. This work will be carried out at the joint BNR/INRS research facilities.

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Name/Nom: FRASSON, Claude

Department/Département: d'informatique et de recherche opérationnelle

University Université: Université de Montréal

Phone number (optional) Nº de téléphone (facultatif):

Title of Project/Titre du projet: Système intégrés et intelligents pour l'enseignement assisté par ordinateur

Cette recherche (projet HERON) a pour but d'étudier systématiquement les contributions possibles de l'intelligence artificielle dans les systèmes d'enseignement assisté par ordinateur et d'aboutir à des prototypes d'enseignement assistés par systèmes experts. Ces prototypes incorporeront différentes formes de présentation d'information comme la voix, l'image, le texte, le graphique fixe ou animé, et pourront fonctionner de manière à être utilisés par une variété d'usagers indépendemment de leur situation géographique.

On procèdera à de nombreuses expérimentations afin de valider un modèle théorique de représentation des connaissances et de déterminer l'apport de diverses composantes intelligentes dans un système d'enseignement.

Des prototypes seront développés dans le secteur de l'informatique et de la bureautique.

L'ensemble des modèles et expérimentations aboutiront à la mise au point d'une méthodologie de développement d'un système d'enseignement intelligent.

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Name/Nom: David Haccoun

Department/Département: Génie Electrique

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Phone number (optional) N° de telephone (facultatif): 340-4548

Title of Project/Titre du projet: Etude et réalisation de codeurs et décodeurs à haute vitesse pour codes convolutionnels.

L'usage de plus en plus répandu de techniques de transmission numériques dans les télécommunications terrestres et par satellite conduit à l'utilisation grandissante de procédures de correction automatique des erreurs ("Forward Error Control" - FEC) par codage de canal, qui sont puissantes, pratiques et fiables. Aussi un problème important consiste à développer et à réaliser matériellement des techniques de codage et de décodage délivrant des performances d'erreur adéquates avec des décodeurs de complexité acceptable, et pouvant fonctionner efficacement à des vitesses pouvant atteindre plusieurs centaines de Megabits par seconde. Ces tendances technologiques conduisent à étudier pour ces systèmes de codage/décodage des architectures efficaces se prêtant bien à des réalisations intégrées à très grande échelle (VLSI), et tendant à minimiser le rapport coût/performance.

Cette recherche porte sur le contrôle des erreurs par codage convolutionnel et a pour objectifs l'analyse théorique, l'étude de l'architecture, l'analyse de la complexité et la réalisation intégrée VLSI de systèmes codeur/décodeur performants.

En plus de l'analyse théorique des performances et de la simulation sur ordinateur des algorithmes de décodage, une attention particulière sera portée sur les compromis entre la simplicité des algorithmes de codage/décodage, les longueurs de contrainte des codes utilisables et la performance d'erreur. L'analyse des considérations pratiques reliant complexité du décodage et faisabilité de réalisation conduira à des réalisations matérielles intégrées VLSI d'encodeur universel, de décodeur à seuil modulaire et de décodeur séquentiel capables d'atteindre les vitesses maximales permissibles avec une technologie au silicium donnée.

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Name/Nom: Prof. P. C. Hughes

Department/Département: Institute for Aerospace Studies

University/Université: University of Toronto

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Title of Project/Titre du projet: CONTROL SYSTEMS FOR LARGE FLEXIBLE SPACECRAFT

SUMMARY

Virtually all the space vehicles currently under study by Canadian government departments have one feature in common: they are much larger and structurally much more flexible than heretofore. Their largeness derives from new, more ambitious mission requirements, as enabled by the availability of the shuttle launch vehicle. Their structural flexibility is the inevitable consequence of their size, combined with the cost of placing mass in orbit.

The problem of controlling the orientation and shape of such satellites has received a great deal of attention for almost two decades, but most of this work, understandably, has consisted of paper studies. This wealth of theoretical/analytical information must now be evaluated in terms of actual performance, and the construction of suitable ground-based experiments is an essential step in the verification process.

Under his previous NSERC Strategic Grant, and in concert with the Space Mechanics Directorate of the Department of Communications, the applicant undertook the design and construction of a laboratory facility to assess and evaluate candidate control strategies for large flexible spacecraft. This facility has now been built and the simple control of a complex structure (many low-frequency, lightly damped oscillations) has been demonstrated.

The current proposal seeks to build on this strength and to take advantage of this newly-created facility. The first year will be spent in an experimental determination of a sophisticated math model of the structure. With the system thus clearly understood, the second year will see the investigation of many crucial questions often ignored in the theory, including controller response time effects, nonlinearities, and controller tolerance of inaccurate information about the structure. In the third year of this grant, advanced sensor and actuator concepts will be developed, including fibre-optics strain/deflection sensors (collaboration with Dr. Measures) and proof-mass actuators.

This research is applicable to the control of communications satellites (e.g., mobile communications satellites with large, offset-fed reflectors), Earth-resources satellites (with large phased-array radars), space-based radar surveillance satellites, and to the control of light, dextrous space manipulator arms (e.g., Space Station).

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University/Université: Université du Québec

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Title of Project/Titre du projet: Very large vocabulary speech recognition

The objective of this project is to develop a system for automatic conversion of spoken sentences to written text. The availability of speech-to-text conversion will bypass the greatest obstacle to increased productivity in computer-aided document preparation: the need to type in the first draft.

The prime scientific focus of this project is the development of an algorithm for the reliable transcription of spoken English sentences. In an attempt to approach virtually unlimited vocabulary speech recognition, we use a very large vocabulary, currently 60,000 words. The algorithm expects the user to leave short (quarter second) pauses between words during dictation. The algorithm includes sufficient acoustic-phonetic knowledge so as to recognize words the system has not heard before based on speech production characteristics observed in other words of the same speaker. Additionally, a language model will predict the a priori probabilities with which specific words may follow a previously input partial sentence so as to maximize the overall word recognition rate.

The above results are intended to be exploited for spoken text entry applications in an office environment. Words misrecognized or not included in the system dictionary will be entered on a keyboard to assist subsequent recognition. This editing environment is expected to resemble current word processor operation so that text input and editing are combined into one integrated applications. We believe that it is the text entry to generate a first draft that represents the greatest obstacle to increased productivity for document preparation today and spoken text entry appears quite promising.

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Name/Nom: Martin D. Levine

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Title of Project/Titre du projet: Range Understanding for Robotics

This project addresses the application of laser rangefinder techniques to robotics with the improved 3D laser instrumentation now available, new research is required to extend these techniques to the development of more intelligent robot systems. These robots should base their decisions on a perception and understanding of their environment. Furthermore the new rangefinding techniques can significantly reduce the user programming effort of a robotic system. In the short term we wish to study in detail how to incorporate three dimensional scene interpretation as sensory feedback for functioning robots. Specific topics to be studied include image acquisition and hardware system integration for image processing, image analysis based on differential geometry, image interpretation and object recognition, and industrial robot applications such as robotic welding.

The new scientific approach, based on differential geometry, provides an object characterization which is independent of translation, rotation, and magnification. As such it is ideally suitable for industrial problems. The synthesis of this theoretical approach with recent advances in 3D rangefinding systems here in Canada promises excellent industrial applications in the near future.

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Department/Département: Electrical Engineering

University/Université: Queen's University

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Title of Project/Titre du projet: Bandwidth efficient modulation and coding for mobile satellite communications

SUMMARY

Satellite communications has long been a major area of Canadian Research and Development. For the past few years there has been considerable interest in Mobile Satellite Communications. Examples are the Canadian MSAT program, which is intended to provide mobile communication services throughout the country, Aeronautical Satellite Communication, which is for Air-Traffic-Control and Messaging, and Maritime Satellite Communication, which is to provide ship-to-satellite links.

The basic bit transmission rates in MSAT are 2400 bps and 4800 bps. In addition, the channel spacing between users in 5 kHz. Thus any signalling strategy must be bandwidth efficient; that is, its baseband, transmitted spectral components must be confined to a spectral spread of 5 kHz.

The main impairment to MSAT, Aerosat and Maritime satellite communications is multipath fading. Over the past few years we have developed bandwidth efficient modulation and error correction coding systems for satellite communication. Recently, we have applied these modulation formats to fading models for MSAT developed at the Communications Research Centre in Ottawa. So far, the results have been very encouraging and systems have been specified which are successful under average channel conditions.

The goal of the present study is to consider our modulation strategies for a variety of mobile satellite communication channels. The specific goals of the project are as follows:

i) To develop a non-coherent receiver structure for multi-h signalling over MSAT channels. The aim is to extend MSAT service to heavy fading scenarios.

ii) To access the improvement due to interleaving that could be achieved for both trellis coded PSK and multi-h signal structures with special emphasis on 2400 bps and 4800 bps services.

iii) To develop real time receiver structures based on the TMS-320 microelectronic chip that would be developed using our existing TMS-320 signal processing station (complete with in-circuit emulation, software development tools, software simulation tools and software library).

and

iv) To extend our MSAT studies to aeronautical satellite channels [5] and to see if signal structures similar to those applied in the MSAT work are applicable.

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- ☐ Open / Ouvert

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University/Université: Sherbrooke

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Title of Project/Titre du projet: "ALGORITHMES DE CODAGE NUMERIQUE DU SIGNAL AUDIO DE HAUTE QUALITE"

Le projet est la réalisation d'un ensemble de logiciels de simulation en temps réel de codeurs numériques du signal audio haute fidélité. Cette réalisation a pour objectif l'évaluation intensive dans des conditions réelles des différentes techniques de codage numérique susceptibles d'être utilisées pour la radiodiffusion directe par satellite.

Le débit numérique important impliqué dans les transmissions audio de qualité ainsi que le besoin intensif d'écoutes pour des tests d'évaluation subjectifs imposent l'utilisation de codeurs fonctionnant en temps réel. Les algorithmes utilisés seront mis en oeuvre sur des microprocesseurs spécialisés pour le traitement du signal (TMS 32010 et TMS 32020) couplés avec un micro-ordinateur permettant le contrôle du codeur et une modification rapide de ses caractéristiques.

Les algorithmes simulés comprennent les principales techniques envisagées jusqu'à présent pour la normalisation de la radiodiffusion directe par satellite: lois A et μ et NICAM 3. Des méthodes nouvelles comme la modulation delta entièrement numérique seront également simulées.

Dans une phase finale de l'étude les codeurs seront évalués en situation réelle notamment en présence d'erreurs sur le canal de transmission.

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Name/Nom: C.A.T. SALAMA

Department/Département: Electrical Engineering

University/Université: University of Toronto, Toronto, Ontario

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Title of Project/Titre du projet: MICRON AND SUBMICRON INTEGRATED CIRCUIT DESIGN FOR TELECOMMUNICATIONS APPLICATIONS

The objectives of the present work are to investigate the modeling and design methodologies useful in the implementation of micron and submicron CMOS analog and digital integrated circuits with particular emphasis on telecommunications applications. Specific objectives include modeling micron and submicron CMOS devices and the design and implementation of a variety of analog and digital macrocells. Emphasis will be on innovative design techniques which can make use of high performance CMOS technology.

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- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: L. Shafai and E. Bridges

Department/Département: Electrical Engineeering

University/Université: Manitoba

Phone number (optional)/N° de téléphone (facultatif): (204) 474-9615

Title of Project/Titre du projet: Antenna Development for Land Mobile Satellite Communication

The research proposed in this application will focus on the design, fabrication, testing and implementation of suitable UHF vehicular antennas for use with Canadian Land Mobile Satellite Communication, "MSAT". The main objectives of this study are: to identify antenna configurations that will provide acceptable electrical performance, have geometries suitable for use on private and commecial vehicles and can be implemented at low cost. The electrical performance will be taylored for Canadian applications, to provide a minimum gain of 8 dB_i and an ellipticity of better than 3 DB, in the coverage zone centered around 25° elevation. Both low and medium profile geometries will be considered, designed and optimized.

To minimize the system complexity, various methods of beam scanning will be studied and candidates with low implementation cost and small insertion losses will be selected. Since beam forming networks using phase shifters are the main source of the gain loss and the system cost, efforts will be made to identify novel designs to reduce both the loss and cost.

Various tracking systems will also be studied and tested to select a potential candidate for implementation. The overall system of the antenna, beamforming network and the tracking system will then be integrated and examined in a field test environment.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☒ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology/ Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☐ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: C.Y. Suen

Department/Département: Computer Science

University/Université: Comcordia University

Phone number (optional)/N° de téléphone (facultatif): (514) 848-3006

Title of Project/Titre du projet: Optical Character Recognition Algorithms and Architectures

This research is related to the use of computers to recognize machine-printed and handwritten characters and symbols and the design of suitable architectures for direct implementation of such algorithms. It includes the following investigations:

(a) Preprocessing, the use of different types of convolution to clean and smooth the raw images obtained from the optical scanner.
(b) Feature extraction, identification and extraction of distinctive features from the digitized characters.
(c) Recognition and classification, the use of different sets of distinctive features and knowledge to identify the characters, and the study of discriminant functions, clustering procedures, decision trees and syntactic and statistical pattern recognition methods.
(d) Processor architecture studies, analysis of the use of data-flow and control-flow architectures to support image processing, feature extraction, and pattern classification leading to potential implementation in VLSI.

Apart from the interesting theoretical and practical aspects of computer recognition of characters, our findings have direct scientific and economic impact on computer reading of printed and handwritten data and documents in office automation and text processing, reading and processing of mail, cheques, income tax returns, engineering drawings, maps, and other documents.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one cocher la case appropriée)

- ☐ Biotechnology / Biotechnologie
- ☒ Communications and Computers / Telecommunications et informatique
- ☐ Energy / Energie
- ☐ Environmental Toxicology / Toxicologie de l'environnement
- ☐ Food-Agriculture / Alimentation-Agriculture
- ☐ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: REAL TREMBLAY

Department/Département: PHYSIQUE - LROL

University/Université: LAVAL

Phone number (optional) N° de téléphone (facultatif): (418) 656-7368

Title of Project/Titre du projet: ALL-OPTICAL WAVEGUIDING BISTABLE DEVICE FORMED IN SEMICONDUCTOR-DOPED GLASS

The goal of the proposed research project consists in constructing a prototype of an all-optical bistable device in waveguiding geometry. The devices of this kind can find application in optical signal processing and communication systems. The advantages of these devices include potentially high switching speeds in serial arrangements and high parallel signal throughputs.

The concept of the bistable device proposed is based on a combination of optical nonlinearity and feedback. In so called nonlinear optical materials the index of refraction can be varied by changing the intensity of light illuminating a piece of the mentioned material or by changing the intensity of light propagating in a waveguide made of such a material. We propose to utilize CdS_xSe_{1-x} semiconductor-doped glasses, commercially available as color glass filters as a main raw material (nonlinear optical medium). The feedback in the bistable device proposed is provided by a Fabry-Perot resonator also in a waveguiding configuration.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☒ Communications and Computers / Telecommunications et informatique	☐ Energy / Energie	☐ Environmental Toxicology / Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☐ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Oceans	☐ Open / Ouvert

Name/Nom: G.L. Yip (Professor)

Department/Département: Electrical Engineering

University/Université: McGill University

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Title of Project/Titre du projet: Integrated Optics for Optical Communications

The overall objectives in our research are to investigate the properties of various optical waveguides and waveguide devices, i.e. fiber and integrated optical devices, and to explore their applications in fiber optical communication systems such as CATV. In addition to training graduate students for employment in Canada's optical communications industry, it is hoped the end product of our research will be to provide detailed information on optical waveguide devices to potential users in industries and government agencies to assist in their design and manufacture and also their system applications.

Since September 1978, our efforts in integrated optics have been mainly concentrated on fabricating passive and active optical branch waveguide devices in $LiNbO_3$. $LiNbO_3$ is a very promising substrate material for an integrated optical circuit because of its excellent electrooptic properties. Since these waveguide devices have a wide base bandwidth of 10-20 GHz, they are applicable to optical fiber communication systems such as telephone networks, CATV systems and optical computing systems.

In this program, proposals have been made to investigate the design, fabrication and measurements of two $Ti:LiNbO_3$ (tatanium in-diffused lithium niobate) planar waveguide devices, i.e. (1) an active 3-branch waveguide power divider/switch and (2) a linear mode confinement modulator. Due to the electro-optical effects present in $LiNbO_3$ crystals, it is possible to control the flow of optical power in each channel of the devices. In the first device, by connecting an input fiber to the main guide in the device and three fibers to the three output branches, it is possible to divide or switch power between the central branch and each of the side channels at a desired ratio, by simply varying the electrode voltage. In the second device, power from one fiber can be modulated with either an analogue or digital signal and then coupled into another fiber, which will now carry the desired signal for transmission.

LIST OF ON-GOING RESEARCH PROJECTS / LISTE DES PROJETS DE RECHERCHE EN COURS

Name/Nom Department/Département University/Université	Title/Titre	$*
1. General Techniques for Information Technology / Les techniques générales en technologie de l'information		
Adoul, J.P. Génie électrique Sherbrooke	State of the art digital coding of speech for mobile radio and new services * avec P. Mabilleau, S. Richard, J. Soumagne, N.Boutin, S. Morissette (Sherbrooke)	196,840
Baecker, R.M. Computer Science Toronto	Enhanced processing of visual displays * with P.M. Muter, A. Fournier, I. Spence (Toronto), D. Olson (Ont. Inst. for Studies in Education)	285,000
Haykin, S. Elec. & Comp. Eng. McMaster	Multidimensional sampled aperture radar processing	234,482
Kabal, P. Electrical Eng. McGill	Digital signal processing for coding of speech and video signals * with E. Dubois, P. Mermelstein, B. Prasada (INRS)	291,900
O'Shaughnessy, D. INRS-Télécomm. Québec - INRS	High-quality text-to-speech synthesis * with P. Mermelstein, M. Lennig (INRS)	210,080
2. Systems / Systèmes		
Burkowski, F.J. Computer Science Waterloo	The Sylvan Project: The design of a message-based multiprocessor * with G.V. Cormack, J.D. Dyment, J. Pachl (Waterloo)	319,190
Cerny, E. Infor. & rech opér. Montréal	Hierarchical mixed-mode simulation for VLSI * with J. Gecsei, M. Aboulhamid (Montréal)	264,000
Mahmoud, S. Sys. & Comp. Eng. Carleton	Design strategies for VLSI implementation in digital communications (with special application to cellular and portable radio systems) * with C.H. Chan, M.A. Copeland, D.D. Falconer, R.H. Hafez, A.U.H. Sheikh, J.S. Wight (Carleton), P. Galko, W. Steenaart (Ottawa)	582,000
Salama, C.A.T. Electrical Eng. Toronto	High voltage CMOS compatible integrated circuit design	156,000

*Total funds committed / Montant total accordé

Name/Nom Department/Département University/Université	Title/Titre	$*
3 Networks / Réseaux		
Bochmann, G. Infor. & rech opér. Montréal	Protocol design and implementation tools * avec E. Cerny (Montréal)	221,536
Donaldson, R.W. Electrical Eng. UBC	Modems and protocols for local communication applications * with S.T. Chanson, H.W. Lee, C.S. Leung S.T. Vuong (UBC)	240,000
Georganas, N.D. Electrical Eng. Ottawa	Integrated data/voice/image communications on local area networks * with M. Goldberg, S. Cohn-Sfetcu (Ottawa)	270,000
Mason, L.G. INRS-Télécomm. Québec - INRS	Virtual networks * with A. Girard, M.J. Ferguson (INRS)	207,560
Tavares, S.E. Electrical Eng. Queen's	Security in distributed computer systems * with S.G. Akl, G.H. MacEwen, H. Meijer, P.D. Taylor (Queen's)	285,500
4. Artificial Intelligence / L'intelligence artificielle		
Gonnet, G.H. Computer Science Waterloo	A powerful, compact, and efficient symbolic computation system * with B.W. Char, K.O. Geddes, J.H. Johnson (Waterloo)	268,853
Jenkins, M.A. Comp. & Info. Sc. Queen's	Integrating logic programming and data bases * with J.I. Glasgow (Queen's)	294,000
Lochovsky, F.H. Computer Science Toronto	An office procedure manager * with D.C. Tsichritzis, A.O. Mendelzon, S. Christodoulakis (Toronto)	316,680
Tsotsos, J.K. Computer Science Toronto	A second generation expert systems technology * with J. Mylopoulos, G.J. Hirst, A.D. Jepson, H. Levesque, R. Reiter (Toronto)	995,000
Van Emden, M.H. Computer Science Waterloo	Logic-mediated, knowledged-based personal information systems * with R. Aleliunas, R. Cohen, R.G. Goebel, M.L. Jones, D.L. Poole (Waterloo)	450,000

*Total funds committed / Montant total accordé

Name/Nom Department/Département University/Université	Title/Titre	$*
5. Transmission / Transmission		
Delisle, G.Y. Génie électrique Laval	Modélisation du canal radio-mobile numérique en milieu urbain * avec M. Lecours (Laval)	155,680
Feher, K. Electrical Eng. Ottawa	Digital satellite earth station modems	276,000
Langley, R.B. Surveying Eng. New Brunswick	Geodetic and geodynamic applications of space-based positioning systems * with D.E. Wells, J.M. Tranquilla (UNB)	120,000
Modi, V.J. Mechanical Eng. UBC	Dynamics and control of large communications satellites	184,620
Vanstone, S.A. Combin./Optimiz. Waterloo	Cryptographic systems and protocols * with R.C. Mullin, G.B. Agnew (Waterloo)	330,000
6. Components, Devices and Materials / Composants, dispositifs et matériaux		
Hoefer, W.J.R. Electrical Eng. Ottawa	CAD/CAM of quasi-planar circuits for millimeter-wave communications	200,940
7. Terminals and Communications Interfaces / Terminaux et interfaces de télécommunication		
Booth, K.S. Computer Science Waterloo	Effective interactive computer graphics in workstation environments * with R.H. Bartels, J.C. Beatty, M.P. Bryden, D.E. Field, P. Jolicoeur (Waterloo), W.B. Cowan (NRC)	483,073

*Total funds committed / Montant total accordé

LIST OF SUMMARIES OF COMPLETED PROJECTS

LISTE DES RÉSUMÉS DES TRAVAUX DE RECHERCHE TERMINÉS

Name/Nom Department/Département University/Université	Title/Titre	$*	Page
1. General Techniques for Information Technology / Les techniques générales en technologie de l'information			
Arsenault, H.H. Physique Laval	Optical and digital signal processing	167,600	55
Carter, C.R. Elec. & Comp. Eng. McMaster	Signal processing of real SARSAT signals	135,000	60
2. Components, Devices and Materials / Composants, dispositifs et matériaux			
Bures, J. Génie-physique Polytechnique	Coupleurs variables à fibres optiques monomodes fusionnées	195,000	58
Hruska, C.K. Mathematics York	Piezoelectricity research laboratory: nonlinear properties and stability of piezoelectric resonators for frequency control and selection	117,900	66
3. Transmission / Transmission			
Bandler, J.W. Elec. & Comp. Eng. McMaster	Optimal tuning of microwave filters and multiplexing networks	167,850	56
Delisle, C. Physique Laval	Systèmes bistables pour les communications optiques	118,500	61
Haccoun, D. Génie électrique Polytechnique	Analysis and implementation strategies of powerful error control codecs	159,800	63
Shafai, L. Electrical Eng. Manitoba	Antenna development for Canadian satellite applications	264,500	72
Taylor, D.P. Elec. & Comp. Eng. McMaster	Simple sequence-based receiver structures for digital satellite communications	39,500	74

*Total funds awarded / Montant total accordé

Name/Nom Department/Département University/Université	Title/Titre	$*	Page
4. Networks / Réseaux			
Hayes, J.F. Electrical Eng. Concordia	An optical fibre based local area network	175,700	64
Mark, J.W. Electrical Eng. Waterloo	Integrated services using local area communication networks	398,612	67
Probert, R.L. Computer Science Ottawa	A communications protocol testing system & related software productivity aids	190,500	70
5. Terminals and Communication Interfaces / Terminaux et interfaces de télécommunication			
Carey, T. Comp. & Info. Sc. Guelph	A specification toolkit for interactive dialogue control	107,676	59
Dillon, R.f. Psychology Carleton	A human factors investigation of function keys and voice recognition	120,175	62
Tompa, F.W. Computer Science Waterloo	Data structuring for page-oriented database systems	196,900	75
6. Artificial Intelligence / L'intelligence artificielle			
Bochmann, G.V. Inf. & rech. opér. Montréal	Databases for videotex: cooperation and application in office automation	301,277	57
Mylopoulos, J. Computer Science Toronto	Design, implementation and testing of a semantic data model: The Taxis Project	310,800	68

*Total funds awarded / Montant total accordé

Name/Nom Department/Département University/Université	Title/Titre	$*	Page
7. Systems / Systèmes			
Holt, R.C. Computer Science Toronto	Software development system for embedded microprocessors	289,926	65
Ostlund, N.S. Computer Science Waterloo	The systolic loop: a multiple processor architecture enabling efficient interprocessor communication	115,452	69
Rumin, N. Electrical Eng. McGill	Design and testing of VLSI circuits	243,880	71
Sorenson, P.G. Computer Science Saskatchewan	Computer-aided information systems analysis and design	139,800	73
Woodside, C.M. Systems and Comp. Eng. Carleton	Modelling and optimization of hardware/software tradeoffs for communications protocols	81,288	76

*Total funds awarded / Montant total accordé

SUMMARIES OF COMPLETED PROJECTS

RÉSUMÉS DES TRAVAUX DE RECHERCHE TERMINÉS

Name/Nom: Prof. Henri H. Arsenault
Department/Département: département de physique
University/Université: Université Laval
Phone number(Optional)/N° de téléphone (facultatif): (418) 656-2650
Title of Project/Titre du projet: Optical and digital image processing

This research dealt with optical and digital image processing techniques. The objective of the project was to develop image processing techniques for rotation-invariant pattern recognition, for processing images in signal-dependent noise, and to develop human and robot perception models. Rotation-invariant pattern recognition techniques were developed using single and multiple circular harmonic matched filters. Such filters are invariant under shifts and rotations of the objects. Studies on the effects of noise and clutter were done. Composite Circular harmonic filters were also developed to combat the effects of sidelobes. For processing images in signal-dependent noise, a generalized homomorphic transformation was developed. This transformation allows the transformation of any signal-dpendent noise into additive noise. The images can then be processed using classical techniques for additive noise. The method was used mainly for image restoration and to determine the information capacity of images degraded by speckle. The results are applicable to synthetic aperture radar. The method was extended to locally-adaptive techniques, one of which may be used even when the model of the noise is unknown. A new model for optical content-addressable associative memories was developed. This model modifies the classical Hopfield neural network model by addding interneurons between the neuron layers. This memory perforns much better than the Hopfild model. Among the application areas of this research are processing of synthetic-aperture radar imagery, robot vision, real-time pattern recognition from air photographs or sensors, medical image interpretation and automatic guidance systems

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4. Arsenault H. H. and Levesque M., Local Stanstics image restoration in the absence of a model for signal dependent noise, Proc. of ICO-13, Optics in modern science and technology, 24 aout 1984, Sapporo, Japan, 220-221, 1984
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25. B. Macukow and H. H. Arsenault, An optical associative memory model based on neural networks having variable interconnection weights, Appl. Opt. 1987 (in press).

Name/Nom: Dr. John W. Bandler
Department/Département: Electrical and Computer Engineering
University/Université: McMaster University
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Title of Project/Titre du projet: OPTIMAL TUNING OF MICROWAVE FILTERS AND MULTIPLEXING NETWORKS

This project was directed towards producing a software system to integrate the analysis, design, testing, experimental tuning and production alignment of microwave filters and multiplexers for satellite communication systems. State-of-the-art optimization techniques capable of handling a large number of variables and constraints were to be linked with available simulation packages to facilitate efficient sensitivity analyses, design centering and tolerance assignment taking integrally into account postproduction tuning variables. Software to locate faulty or out-of-tolerance components based upon input-output frequency response measurements of appropriate filter units were to be produced. Strategies to determine the tuning variables to be adjusted experimentally for a particular manufactured and tested outcome from specified tuning candidates were to be programmed.

Computer programs were to be documented and written in standard Fortran. Packages were to reflect the data and specifications of ComDev Ltd. of Cambridge, Ontario, with whom close interaction and cooperation was planned.

A typical problem is to solve for a 5-channel, 11 GHz multiplexer design, an optimization problem with total of 75 nonlinear variables and 66 functions. For a 12 channel multiplexer problem we could have as many as 180 nonlinear variables (15 variables per channel) to be optimized.

A powerful model parameter identification technique employing the ℓ_1 norm was developed. Data specially prepared at ComDev Ltd. was processed with astounding correlations between experimental responses and theoretical predictions. These are the first results where individual couplings in a manufactured filter were successfully isolated from other effects without disconnections.

We have completed coding and testing a theoretically justified decomposition approach which will permit the effective tuning of highly complex microwave structures. It has been tested on a simulated 16-channel 12 GHz multiplexer structure involving 240 variables.

A tremendous acceleration in industry-university interaction has resulted from the formulation and execution of this strategic grant. There is interest by Canadian industry for our spinoff work in optimal processing of analog circuit measurements for modelling and deembedding of active and passive microwave devices.

Our group has a well-established system of dissemination of results through publication, consulting, education and software demonstration. Through personal discussion, seminars, consulting and contracts, we transfer our knowledge and expertise to industry. Basic software and principles to be employed are being field tested by major corporations involved in microwaves and aerospace communications.

Selected Bibliography

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FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☒ Communications and Computers / Telecommunications et informatique	☐ Energy / Energie	☐ Environmental Toxicology / Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☐ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: Gregor v. Bochmann
Department/Département: Informatique et recherche opérationnelle
University/Université: de Montréal
Phone number (optional)/N° de téléphone (facultatif):

Title of Project/Titre du projet: Databases for videotex: cooperation and application in office automation

This research has been carried out in five areas:

a) Implementation of a menu selection database

A first version of a menu selection database system was implemented on a VAX computer, and has been used for the construction of a small database about the educational aspects for our Department, and other small databases. An improved version of the software was integrated into the system described under point (b). In constrast to many traditional videotex databases, this database software supports arbitrary relations between different pages of the database.

b) Database access transfer protocol for interworking in distributed videotex systems

An "Application protocol" (in the sense of OSI) was designed for the access of external menu-oriented databases for videotex applications. It allows the videotex access machine (VAM, or concentrator) to obtain selected pages from an external database for many simultaneous videotex users.

This protocol has been implemented between a VAX computer and an external Telidon database residing on our PDP-11 computer. The implementaiton was made in the framework of a research contract with Digital Equipment Corp.

c) Data browsing

We developed a new approach to browsing in databases containing collections of objects and associated descriptions. The support for browsing is a lattice of subsets of documents and descriptions. The lattice structure is based on the keywords associated with the documents.

This database browsing approach can be used for various applications, with small to medium sized heterogeneous such as found in office systems, videotex, real estate, travel industry etc.

d) Study of the architecture for applications with down-loaded software

We developed two versions of protocols for formatting, storing and transmitting telesoftware pages from a standard, page-oriented database into an intelligent terminal. The terminals in question are the IBM-PC and the Atari 800 personal computers.

e) Menu-selection databases for computer aided education

The micro-computer version of the menu selection database mentioned under point (a) was extended in several ways in order to build a system suitable for computer-aided instruction and course management. The extensions include the recording of user interactions in a trace file, which can be consulted by a previleged user (usually the "teacher"), and a program for reconding the results of tests which are prepared by the teacher similarly as normal information pages. The system has also been extended to allow for response analysis.

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University/Université: Ecole Polytechnique de Montréal
Phone number(Optional)/N° de téléphone (facultatif): (514) 340-4577 - 340-4793 .
Title of Project/Titre du projet: "Coupleurs variables à fibres optiques monomodes fusionnées"

Les objectifs initiaux du projet étaient de développer des coupleurs à fibres optiques monomodes fusionnées pour réaliser un commutateur électro-optique monomode, en ajustant les puissances de sortie par modification de l'indice du milieu extérieur baignant le coupleur(1-2). L'idée était d'utiliser l'anisotropie des cristaux liquides nématiques à condition d'obtenir des fibres monomodes à indice supérieur à ceux des cristaux, ou des cristaux liquides à faibles indices. Nos démarches pour nous procurer ces produits spéciaux se sont soldées par un échec et nous avons dû réorienter nos recherches sur les propriétés fondamentales des fibres monomodes effilées ou "tapers" biconiques, que l'on peut considérer comme l'un des éléments de base des coupleurs.

En plus d'avoir considérablement amélioré les techniques de fabrication de ces éléments et les mesures de transmission dans ces guides (mesures précises des élongations, contrôle du positionnement de la flamme, fabrication de micro-cellules à cristaux liquides et système informatique associé), nous avons obtenu les résultats suivants concernant la transmission du mode fondamental HE_{11} dans ces structures, qui présente un caractère oscillatoire dépendant de l'élongation, de la longueur d'onde et du milieu extérieur.

-Elongation: les oscillations de transmission sont de plus en plus serrées avec l'allongement(3).

-Longueur d'onde: la position des extrema des oscillations quasi-sinusoïdales peut être prévue à l'avance et on peut combiner plusieurs "tapers" en série pour obtenir un filtre spectral à bande étroite, centré sur une longueur d'onde prédéterminée(4).

-Milieu extérieur isotrope: oscillations pour $n < n_{cladd}$, transmission minimale pour $n = n_{cladd}$ et remontée monotone pour $n > n_{cladd}$(5). Une petite perturbation locale (mince film d'huile) a permis de visualiser et de positionner les régions de battements et de couplages entre modes HE_{1m} (à noter que dans la région du "waist", le noyau est de dimension négligeable et la structure est multimode)(6).

-Milieu extérieur anisotrope (cristal liquide d'indices $> n_{cladd}$): un changement de transmission a été mis en évidence par application d'un champ électrique sur la cellule(7).

-Travaux théoriques: modèle de couplages et de battements dans une nouvelle approche théorique dite de l'approximation "soudaine" où les zones de couplages sont très droites, ces derniers se calculant par des intégrales de recouvrement $HE_{11} - HE_{1m}$(3). Evolution des champs HE_{11} et HE_{12} dans le modèle "à trois couches" incluant le milieu extérieur ("cladding" fini)(8), notion de coupure du mode fondamental(9) et influence de l'anisotropie du milieu extérieur sur la fibre (sélecteur de modes TE_{01} ou TM_{01})(10).

Une retombée technologique importante est à prévoir à la suite de nos travaux: en effilant convenablement deux fibres, monomode et multimode, on peut entrevoir la possibilité de réaliser un connecteur "multimode-monomode" avec des pertes acceptables.

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Title of Project/Titre du projet: A Specification Toolkit for Interactive Dialogue Control

Today's complex software products are developed by teams of designers, programmers, and managers. These teams need formal specifications to communicate the behaviour of the intended product, and to co-ordinate their efforts.

A number of methods are widely available for specifying the functions in traditional computing, but formalizing the behaviour of interactive software is still an evolving research area. The problem is particularly acute when a single application program may run on several different devices or be used by several user classes. Some programs have to be integrated with various other members of a product line, with a standard user interface.

The problem of describing the design of a user interface has been addressed in research conducted by Dr. Tom Carey, assisted by Dr. Dick Mason and Dr. Amelia Fong Lochovsky, at the University of Guelph. With the assistance of interface designers from Canadian software companies, a specification method has been developed which separates the dialogue style of the interface from the functions available in the underlying application. The specification allows for different styles of interface to be combined with one application, and for several applications to share a common style.

The specification method has been implemented in a prototype toolkit for designers of interactive software. The toolkit captures the designers' intuition about the organization of the user interface, and the constraints and effects of user actions.

The research results have been presented in the following publications (available as research reports from the Department of Computing and Information Science, University of Guelph) :

Carey, T.T. The gift of good dialogue tools, in H. Hartson, ed. Advances in Human Computer Interaction, Ablex Publishers, July 1987.

Carey, T.T. Formal specification of user interfaces: a modular approach, International Journal of Man-Machine Studies, to appear 1987.

Carey, T.T. Evaluation of user interface specifications, 4th Symposium on empirical foundations of information sciences, Atlanta Ga., October 1986.

Carey, T.T. and C.H. Graham, The modular specification of user interfaces : two case studies, to be presented at IFIP Interact '87, Stuttgart, F.R.Germany, September 1987.

Carey, T.T. and A. Fong Lochovsky, Modelling task structure in interactive software, to be presented at IFIP Interact '87, Stuttgart, F.R. Germany, September 1987.

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JAN 29 1987

Title of Project/Titre du projet: SIGNAL PROCESSING OF REAL SARSAT SIGNALS

OBJECTIVES:

1) to develop a high level of expertise in processing SARSAT signals.
2) to investigate a matched filter processor for SARSAT signals.
3) to develop a high spectral resolution processor for SARSAT.

ACCOMPLISHMENTS:

Using actual dot chart records obtained over a 2 month period, it was found that approximately 70% of all passes contained some form of interference [9]. A special signal processor has been developed by using ordered statistics which greatly reduces these effects [3,10]. Results show that ELT signals can be separated from many types of interference by recognizing their distinctive modulation characteristics [2,5,7].

For a one second duration of signal assuming the use of 50 blocks of 20 ms rectangular-windowed signal (1K FFT), the minimum detectable carrier-to-noise ratio is approximately 21 dB-Hz [1,4,8]. A matched filter based on the FFT and the inverse FFT (to convolve the modulation) has been developed which realizes a 3 dB improvement in detectability.

Best location estimate depends on very accurate carrier frequency estimates. Using the MEM and ARMA processors, sinusoids and modulated sinusoids, testbed signals and satellite pass data were processed using different selections of ARMA ranging from ARMA(2,2) [6] to ARMA (100,100). It was found that the high order ARMA estimates give very good performance with coherent ELT signals and low order ARMA and MEM estimates are particularly useful in deducing the carrier frequency of signals with poor FFT spectral properties. A special tracking baseband processor has been developed to fully exploit these developments.

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4. M. Dessouky and C. R. Carter: 'Baseband processor for SARSAT signals', accepted by Canadian Electrical Engineering Journal.
5. M. Dessouky and C. R. Carter: 'Spectral analysis of ELT signals for SARSAT', accepted by IEEE Trans. on Aerospace and Electronic Systems.
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Title of Project/Titre du projet: "Systèmes bistables pour les communications optiques"

Cette recherche a porté sur un système bistable acoustooptique à rétroaction retardée, de même que sur sa version intégrée. Nous avons observé le phénomène de bifurcations, la série de Feigenbaum de doublements de fréquences, la série inverse de Lorentz, le chaos, des fréquences à modes synchronisés, des fenêtres d'oscillations périodiques à cycles paires et impaires dans le chaos, des transitions accompagnées d'hystérésis. Nous avons mis en évidence l'existence de modes, lesquels nous ont permis d'expliquer les oscillations à modes synchronisés (frequency locked), et de découvrir de nouvelles routes vers le chaos. Nous avons fait une étude comparative poussée entre deux modèles mathématiques caractérisant notre système, soit une équation aux différences et une équation différentielle aux différences pour établir un parallélisme entre les manifestations propres à chacune d'elles. Nous avons étudié également l'effet du bruit sur le système. En optique intégrée, nous avons pu incorporer la ligne à retard sur le même substrat que le modulateur acoustooptique planaire. Nous avons aussi construit un système bistable intégré à réflexion totale interne basé sur l'effet électrooptique. Ce système est plus rapide (GHz) que le système acoustooptique (MHz), mais limité dans ses applications en raison de l'effet photoréfractif. Cet effet peut toutefois servir pour construire des compteurs optiques qu'on n'a pas réussi cependant à reproduire identiquement.

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Title of Project/Titre du projet: A human factors investigation of function keys and voice recognition

The objectives of this grant were to develop human factors guidelines in four aspects of the human computer interface: 1) the use of programmable function keys for command input, 2) the use of speech for command input, 3) the use of speech for data input, and 4) integrated input systems.

Objective 1. Programmable function keys. Our recommendations focus on six interrelated issues: (1) the necessity to provide function key labels, (2) the importance of meaningful labels, (3) where labels should be placed, (4) spatial separation of keys, (5) organization and (6) conceptual grouping in the assignment of commands to key positions.

Programmable function keys can play an important role in small applications, particularly for the general public (e.g. automatic teller machines). However, they are less adaptable to complex applications than using a pointing device to make selections from a menu system of some type. The advantage of the pointing device approach is that selection is made on the label; therefore, lining up a label with a key is not a requirement, and the labels are easily modified under program control.

To consider more carefully various selection devices for direct screen selections we eventually developed a working prototype of a programmable input device. This device uses a second video display (or eventually a flat panel display or a second large window in a single, high resolution display) to display labels. Mouse, digitizer, touch and voice are available for command selection. The number, location, size, labelling and function of labelled keys or so-called "light buttons" can be changed under program control as needed, leading to what is effectively an extensible programmable function key device. Furthermore, syntax/procedural errors are essentially non-existent since all options required for a command are selected by pointing at them. Our preliminary experience indicates that the command panel concept has excellent potential for making it possible to learn and to use complex applications easily (Dillon, 1986).

Objectives 2 and 3. Speech input of commands and data. With the speech recognition technology available now and forseeable for the near future, there appears to be an important, but clearly defined role for speech input. Speech can be used effectively for command input, particularly with a predetermined set of available commands displayed on the screen. Speech input is particularly effective for activities that require use of the hands and attention to the details of a display. With the available commands displayed in a menu for speech recognition input, the user has the choice of looking at them if needed, or of ignoring menu labels if the commands are known. Thus, a novice has the advantage of reminders inherent in a menu system, while an advanced user, by ignoring the menus, has access to what is effectively a voice activated command system. With the technology currently available, and forseeable for the near future, speech should generally not be used for unlimited text/data input. The use of speech for commands but not text/data has the advantage that there is a natural separation between input modes and data--anything spoken is a command.

Disadvantages of voice commands include the difficulty of voice input in a shared workspace, the need to train the system to each user's voice with current speech recognition technology, and the possibility that inaccurate recognition by the speech system will disrupt users' cognitive processing. Because of these potential difficulties, in most applications, voice recognition should be used in conjunction with an alternative menu selection technique.

Objective 4. Integrated input systems A well integrated system should include (1) command selection by voice input plus alternative means to select items from menus, (2) a pointing device for positioning and moving objects, and (3) a keyboard for text/data input (Dillon, 1986). It is also apparent that it is impossible to design a single interface that meets the needs of all people at all times. Therefore, we have developed prototype interfaces that adapt automatically as the user makes the transition from novice to expert and that the user can easily tailor to meet his own needs.

Throughout our research we have developed and utilized pragmatic user testing techniques that can be used in the design of human-computer interfaces.

Dillon, R.F. (1986) Separation of Functions in user-computer interface design. Paper presented at ACM SIGCHI Workshop on Mixed Modes of Interaction, Key West, Florida, December 1986. (Scheduled to appear as a chapter in book of workshop proceedings).

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FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

- ☐ Biotechnology / Biotechnologie
- ☐ Food-Agriculture / Alimentation-Agriculture
- ☒ Communications and Computers / Telecommunications et informatique
- ☐ Industrial Materials and Processes / Materiaux et procedes industriels
- ☐ Energy / Énergie
- ☐ Oceans / Océans
- ☐ Environmental Toxicology / Toxicologie de l'environnement
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Title of Project/Titre du projet: Analysis and Implementation Strategies of Powerful Error Control Codecs

In advanced digital communications systems and especially in satellite communications, the advantages and potential benefit provided by Forward Error Correction (FEC) are increasingly recognized, and thus error control coding is becoming an essential element in these systems. In FEC systems the main difficulties usually reside at the decoder, and one of the problems standing in the way of the widespread use of FEC techniques is the material realization of powerful decoders that can operate at high data rates with high efficiency, and deliver low error probabilities while being practical to implement.

The objectives of this research project is to explore analytically and experimentally the implementation strategies of powerful encoders and decoders for channel error control. The project involves the two large classes of FEC, namely block coding and convolutional coding. A particular attention was given to Goppa codes, Reed-Solomon and BCH decoders, and Unequal Error Correction for block codes, whereas for convolutional codes Viterbi, sequential and threshold decoders were emphasized. In addition to code performance, hardware codecs have been developed with a special emphasis on VLSI implementation designs.

Several practical designs and realizations have been achieved, in particular: 1) A(511,493) two-error correcting BCH codec. This design is being implemented using 2 micron VLSI CMOS technology. 2) A Viterbi decoding codec suitable for both low fixed rate and punctured high rate codes has been constructed. This machine can deliver 156Kbps with a code of constraint length 7. 3) A fast (25 Mbps to 75Mbps) one-chip programmable universal convolutional encoder has been fabricated in a CMOS 3-micron VLSI technology. 6) A single-chip fast threshold decoder has been designed and manufactured using 3-micron VLSI technology. The 5500 transistor chip implements a rate 1/2, constraint length 40 convolutional code. 5) The architecture of high-speed (500 Kbps) and high performance sequential decoder using the stack algorithm has been developed as a step towards a VLSI implementation of this complex decoder.

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Title of Project/Titre du projet: An Optical Fiber Based Local Area Network

Optical fiber possesses features that make it attractive as a transmission medium in LANs - low transmission loss, high bandwidth, immunity to electromagnetic interference and ease of installation. Over the last three years a network designed to utilize these properties of optical fiber was designed and built. The network has been designated as a Local Backbone Network (LBN) since its function is to connect a limited number of high volume sources to one another. The network may be used to convey traffic between Ethernets as well as voice and video teleconferencing signals.

The network consists of a Central Switch (CS), User Access Nodes (UAN) and the optical fiber itself all configured in a star topology. Users interface the system through ports on the UAN which act as a concentrator. These components are connected to the CS by means of the optical fiber. The CS routes traffic between the optical fiber links. The plan is for a total of sixteen full duplex links into the switch.

The salient feature of the system is the speed of each of these optical fiber links, 44 Mbps. This speed is well within the capability of LEDs transmitting over multimode optical fiber; consequently transmission is quite inexpensive. In fact, in contrast to most communications systems, the limiting resource is not bandwidth, but processing power for switching and multiplexing. Accordingly, the UANs and the CS have been designed so as to trade bandwidth for processing power, enabling the use of nonstandard components.

The basic multiplexing technique for voice, data and slow scan video is Time Division Multiplexing and the basic switching technique is Time Slot Interchange. Short, bursty data traffic, such as that carried on Ethernets, voice and video are conveyed in dedicated TDM slots. Bulk data such as that generated by a workstation is switched by a form of fast circuit switching in which call requests are sent to the CS and bandwidth is allocated.

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Title of Project/Titre du projet: Software Development System for Embedded Microprocessors

The object of this strategic grant was to investigate techniques to make it easier to rapidly develop efficient microprocessor software for embedded applications. An embedded system consists of one or more microprocessors dedicated to performing particular control functions that are an integral part of a larger system. Examples include microprocessors to control engine fuel mixtures and microprocessors controlling digital switching equipment. Typically, once this software is developed it is put into read-only memory (ROM). Whenever the hardware is turned on, this embedded system assumes control.

The grant supported work developing verifiable, portable and highly efficient programming languages that allow software development on supportive host systems to be easily transferred to the embedded system. Several languages (Concurrent Euclid, Euclid Version 2, and Turing) have been developed and are currently in use at a number of universities and companies around the world. Reports cite "a reduction of software development time of approximately eighty percent due to the use of CE [Concurrent Euclid]".

Other research supported by this grant has resulted in a paradigm that makes basic system I/O software easier to write, maintain and transport. This paradigm is supported with a theoretic foundation for the development of device management software that applies mathematical semantics to hardware devices.

Other research results include: a portable systems kernel requiring approximately 200 bytes of assembly code to support the concurrency control and interrupt handling software; and examples of embedded software systems in robotics, digital signal processing and computer aided manufacturing.

As well as technical reports, research results have been distributed as compilers and textbooks. The compilers have been well received and an Ontario corporation has been set up to handle the distribution and licensing of software developed.

A complete bibliography has been included with the final report, the following is a partial list taken from that bibliography.

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D.A. Penny, "A High Level Approach to Writing Software that Controls Peripheral Devices", M.A.Sc. thesis, University of Toronto, Feb 1987.

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Title of Project/Titre du projet: NONLINEAR PROPERTIES AND STABILITY OF PIEZOELECTRIC RESONATORS FOR FREQUENCY CONTROL AND SELECTION

SUMMARY

A plate resonator with the central parts of its the major faces raised (e.g. mesa-shaped) and free of any electrodes and with the exciting electrodes 'wrapping' the opposite edges of the resonator appears to offer several advantageous features such as supression of the unwanted modes of vibration or improvement of the quality factor Q. The same electrode arrangement can be used to enhance the DC field/frequency effect or to minimize it.

The study of the DC field/frequency effect resulted in an accurate determination of six values of the material components of the electroelastic tensor and of the order of magnitude of their temperature dependence. Understanding these nonlinear properties of quartz is vital for theoretical calculations involving the design of modern quartz resonators.

The suggested applications (some of them already realized) of the results to the precision quartz resonators for frequency control and selection are:

1) supression of unwanted modes of vibration
2) improvement of the quality factor Q
3) reduction of noise in precision resonators
4) precision tuning (possibly even frequency modulation)
5) pre-programmed ageing drift compensation
6) identification of quartz crystal impurities.

In addition to it the DC field/frequency effect can be used for determination of other higher order material constants of quartz (e.g. electrostriction).

The results of the study of the DC field/frequency effect undertaken for quartz can also be applied to piezo ceramic materials, where the potential applications of this phenomenon are

1) effective control of the delay time (SAW devices)
2) temperature effect compensation
3) high voltage measurement devices
4) beam steering in phased array antennas
5) efficiency improvement in SAW convolvers.

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
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- ☐ Biotechnology / Biotechnologie
- ☐ Food-Agriculture / Alimentation-Agriculture
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- ☐ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Energy / Énergie
- ☐ Oceans / Océans
- ☐ Environmental Toxicology / Toxicologie de l'environnement
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Title of Project/Titre du projet: Integrated Services Using Local Area Communication Networks

An integrated services local area network with the generic name Welnet (Waterloo Experimental Local NETwork)[1] has been developed under the auspices of a strategic grant. With a capability to provide priority scheduling using a conflict-free access control algorithm, Welnet is intended for supporting a mixture of time-critical and non-time-critical traffic types. A specific example is the integrated services of voice and data, where continuity of real-time speech must be maintained (time-critical traffic) while data (non-time-critical traffic) can be buffered.

Welnet is a bus local area network with an auxiliary control wire, in a ring configuration, for the transmission of scheduling information in the form of tokens. In this way, information transmission and token passing can take place simultaneously. The network stations, which are MC 6809 microprocessor-based with in-house designed transceiver IC boards, are connected to the bus in a multidrop fashion. An active station is permitted to transmit if and only if it possesses a token of the correct traffic type and that the transmission channel is idle. The time-critical traffic (e.g., voice) is given a higher media access priority so that preemption of the lower priority traffic takes place when the time-critical traffic needs the channel.

In its present form, Welnet supports voice, data, facsimile, and file transfer; it is an integrated services LAN suitable as an architecture for the support of communications in the *office of the future* where there is a mixture of different traffic types. The priority scheduling media access control also makes Welnet suitable for local area networking environments where guaranteed channel access for a certain kind of traffic, e.g., in a process control or robotic control environment, is required.

Welnet is currently being used as a testbed for further research in areas such as high level protocol design, network interconnection, network security, database management, performance modelling and evaluation, etc. The technology developed under the auspices of the strategic grant offers potential applications by the user sector. The research team has made technology transfer in the form of seminar presentations and direct discussions with some Canadian companies and is ready to transfer technology to the user sector for licensing and commercialization.

The research team has been active in international standard activities on local area networks, particularly the IEEE 802 standards. The experience gained in the design and development of Welnet is state-of-the-art knowledge and is applicable to many areas of networking. This experience has contributed in a significant way to the development of international local area network standards. In fact, the initial set of working state tables for the IEEE 802.2 Logical Link Control standard was submitted by the Waterloo research team.

The integrated services local area network project has provided an excellent training ground for full-time research assistants, as well as graduate and undergraduate students. A number of theses, both at the doctoral and masters level, with research contents related to the integrated services local area network project, have been completed. Although, the strategic grant itself only had limited funds for supporting graduate students, the research conducted under the auspices of the strategic grant did provide an impetus for graduate research topics. Throughout the tenure of the strategic grant, the project hired, on the average, about two co-op students per term. These are full-time research assistants on their workterms. The training they received on the overall network design and implementation is invaluable.

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2. J.W. Mark, "Integrated Voice/Data Services on a Dual-Ring Local Area Network," IEEE Global Telecommunications Conference, Conf. Record, pp. 377-381, Nov. 29 - Dec. 3, 1983, San Diego, CA.

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Title of Project/Titre du projet: Design, Implementation and Testing of a Semantic Data Model: The Taxis Project

The aim of this project has been to develop languages, tools and methodologies for the construction of interactive information systems, e.g., reservation, point-of-sale inventory control and credit card verification. A basic premise of the project has been that software embodies conceptual descriptions about an application and that consequently useful design languages must offer conceptual modelling facilities [Brodie84]. The results of the project include:

The Taxis design language, which provides means for describing the information content of the proposed information system through an object-oriented framework which supports classification, generalization and aggregation as abstraction mechanisms. A major advantage of this framework over traditional record-based approaches for conceptual modelling purposes is the direct and natural correspondence between the model one builds as he develops his information system and the world (e.g., no reliance on keys), which facilitates the design, access and interpretation of the information handled by the system. **Data classes** are intended to model the entities that are relevant to the subject matter and at the same time will eventually be stored in the database(s) of the information system. In addition, Taxis allows for the specification of dynamic aspects of an information system through **transactions**. Lastly, a procedural exception handling mechanism is provided in order to deal with unexpected situations that might arise in the operation of the system in a flexible manner. The language is supported through a compiler that maps Taxis code into Pascal (augmented with database management facilities). Also, by a Lisp-based interactive environment.

A software development methodology based on the idea of **concept specialization**. According to this methodology, an information system is developed by first describing the most general relevant concepts which can then be specialized to describe special cases and how they ought to be handled by the system under design.

An overview of the Taxis language appeared in [Mylopoulos80], while an overview of the whole Taxis project can be found in [Mylopoulos86]. This overview includes a discussion of other software development issues such as requirements modelling and user interfaces which have been addressed within the research framework of this project. Finally, a description of the implementation of the compiler can be found in [Nixon87].

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Title of Project/Titre du projet: The Systolic Loop: A multiple Processor Architecture Enabling Efficient Interprocessor Communication.

This grant has been used to explore a new multiple processor computer architecture, the "Systolic Loop", as a candidate architecture for high performance supercomputing of the future. The Systolic Loop makes possible a very highly parallel machine that incorporates thousands, or tens of thousands, of processing elements. This is possible because the architecture requires only simple, straightforward interprocessor communication with only two nearest neighbors, and avoids all the communication and synchronization bottlenecks of numerous other proposals for highly parallel computer systems. The architecture involves very modular components connected in simple loop (or ring) topology and has perhaps the simplest implementation and packaging considerations of any parallel machine. The basic idea behind this research involves the discovery that one can map wide varieties of problems onto this very simple topology of processors.

Year 1 of the grant was used to experimentally explore two testbed, bottom-up implementations of the architecture, referred to as Waterloop V1 and Waterloop V2, prior to the design of a new, commercial quality machine, Waterloop V3 in Year 2.

Year 1 involved extensive (design,build,test,redesign) explorations with the 64-processor system Waterloop V2, resulting in a working parallel machine having many innovative architectural features, an operating system (LoopOS V2.0), and implementations of parallel algorithms. Waterloop V2 was one of the first operational 64-processor systems in the world. Some of its features include dynamic reconfigurability (including the ability to dynamically shunt a broken processor out of the system), a hierarchical but modular design that makes it possible to use any number of processor without redesign, and systolic communication channels dedicated to high speed user-process to user-process interaction, separate from normal system communication (network) channels.

Year 2 used the results of this and previous research and the experience gained from the Waterloop V1 and V2 prototypes to design a new machine according to top-down specifications. This machine, Waterloop V3, has not yet been implemented. It includes a very high speed pipelined floating point unit, high speed communication hardware, and a global system architecture that closely resembles the final configuration of Waterloop V2. Efforts are under way to explore the building of a commercial version of the machine.

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Title of Project/Titre du projet: Protocol Testing & Software Productivity Aids

SUMMARY OF RESEARCH PROJECT

Computer Communications is an area of research and technology which is vitally important to the further orderly development of our world. This field involves the study of techniques for allowing a number of geographically remote computer systems and their users to communicate effectively with one another over a communications network. The most universal communications network is the telephone network. This network is being developed into a network which carries data traffic as well as human conversations. This data may be files, requests for services, display screens, etc. One of the most widely used techniques for transmitting data over a computer communications network is called packet switching. Packet switching involves breaking message data up into manageable chunks called packets, transmitting each packet over the network to its destination, and reassembling the packets to form the original message.

Since total chaoes would result if every computer systems had its own method for packet switching, the countries of the world have agreed on a standard set of rules for packet switching. This set of rules is called the X.25 protocol standard or X.25 for short. Any country which follows the X.25 specifications to produce an X.25 protocol implementation should be therefore able to communicate effectively with the other X.25 implementations in the world. Unfortunately, it is not easy to verify that a protocol implementation corresponds exactly or conforms to the protocol standard. A particular kind of testing called conformance testing is necessary to check whether a protocol implementation conforms to the protocol standard.

Since it is possible that different implementors might carry out conformance testing differently, and thus fail to check for the same kinds of conformance, it has been necessary for all countries to agree on standards for conformance testing of protocols. The Protocols Research Group at theUniversity of Ottawa in collaboration with Bell-Northern Research has led the world in research and development into conformance testing standards for X.25 packet switching equipment. In particular, we have designed and developed the first standardized conformance test suite in the world for X.25 data communications terminals. In addition, under the direction of Professor Luigi Logrippo, we have developed the first translator in the world for a protocol specification language called LOTOS which is intended to allow protocol standards to be written in a precise and correct manner. Both of these accomplishments are major achievements which were initiated with the funding provided in this grant.

At stake in this area of work is the dependability of communication networks, affecting the ability of countries to communicate with one another. International commerce can be crippled by serious failures in communications networks. Of immediate interest to Canadians are the employment opportunities created when world markets purchase Canadian communications products. Canadian communications industries are given a competitive edge when the best test suites are made available to them to verify the quality of networking products. It is well known that a reputation for quality helps to sell products. In addition, expertise is now available at the University of Ottawa to assist Canadian firms and government ministries in infIluencing the direction of development of world testing standards.

Thus, NSERC has received excellent return on investment in this project. A rather small three year investment has formed the seed of what has become a major research enterprise. The Protocols Research Group at the University of Ottawa is now responsible for a steady stream of highly trained manpower into the Canadian Communications industry. In addition, the expertise of our research group in specifying and testing protocols is recognized around the world. We are proud of Canada's position in this field and are grateful to NSERC for their support.

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Title of Project/Titre du projet: Design and Testing of VLSI Circuits.

SUMMARY OF COMPLETED STRATEGIC RESEARCH PROJECT

One of the main goals of this work was to develop solutions to the problem of testing very large scale integrated (VLSI) circuits. These were based on the novel concept of built-in -self-test (BIST) wherein the chip is designed to test itself. This approach is very attractive and has generated a lot of interest. However, it is not without problems, some of which include the area occupied by the testing circuitry and the possibility that it can fail. The results of this research provide optimal solutions for many types of VLSI chips. In particular, extremely cost-effective solutions have been optained for programmable logic arrays (PLA) which form important building blocks in many kinds of VLSI chips. The designers of PLAs will also benefit from the exact logic minimization package which was developed under this Grant. It is not only the fastest accurate minimizer in existence, but it also makes much more modest use of computer resources than other known minimization packages. The state of the art in circuit simulation has been advanced with a new switch-level, logic simulator which provides not only fast logic simulation but accurate delay estimation as well. It represents an important addition to the existing hierarchy of design verification tools used by chip designers.

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Title of Project/Titre du projet: Antenna Development for Canadian Satellite Applications

This work was undertaken to investigate the design options for MSAT vehicular antennas, coaxial feeds for reflector antennas and phased array concepts for high gain applications. Because of the urgency in developing the MSAT vehicular antenna this portion of the project was emphasized most. In the initial stage a study was made to select possible antenna candidates. Subsequent research was conducted on 1) microstrip phased arrays, as a low profile unit, 2) drooping dipoles as medium size arrays and 3) a mechanically steerable unit. The latter two were designed and tested. However, because of the attractive features of microstrip phased arrays they were subsequently dropped. In the case of microstrip array a preliminary study indicated that a 19-element dominant mode patch array may provide adequate gain. It was therefore fabricated and tested. It provided a peak gain of 11.5 dB_i, at an elevation angle of 35° and its gain dropped to 7 dB_i around 20° elevation. These measured gains were lower than the computed ones, which was attributed to the mutual coupling effects. A study was then conducted to determine the mutual coupling in microstrip phased arrays, this work resulted in more accurate data, which agreed with experiment. The software generated was then used to re-optimize the array configuration. It was also used to determine the array performance using the higher order TM_{21} mode microstrip elements. This new element provided higher gains of about 13.1 dB_i at an elevation of 30° and its gain reduced to 11.5 dB_i at 20° elevations. Study was also made to select and design the required phase shifters and power dividers the insertion loss of 3-Bit phase shifters was measured to the 1.5 dB.

Coaxial feeds were studied using a numerical method using on the moment methods. Single and dual band feeds were designed and numerically optimized. Their performance on a paraboloid reflector was also studied. The work on high gain microstrip arrays was conducted on a limited scale. Array elements with an adequate bandwidth of about 15 percent were developed and tested. Sample linear arrays of 15 elements were also studied and tested.

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Title of Project/Titre du projet: *Computer-Aided Information Systems Analysis and Design*

This project concentrated on the research and development of computer-aided support for the two initial stages of a computer information system's life cycle -- the analysis and the design stages. The benefits of this research are the development of software tools for analysts and designers that reduce software systems development costs, reduce development time, increase productivity, and help to insure conformity to a given systems development methodology.

Research and development was undertaken on a prototype workstation environment that extended the existing SPSL/SPSA (Simple Problem Statement Language / Simple Problem Statement Analyzer) system. SPSL is a non-procedural requirements specification language based on the entity-relationship model. SPSA compiles and stores SPSL descriptions in a specification database, allows modifications to the database, and produces reports including those that check for system completeness and consistency. The goal of the research was to create an analysis and design "workbench" capability. Support for the Structured Systems Analysis and Design approaches was provided in the form of an icon-based, object-oriented graphics interface, called DEPICT, that displayed data flow diagrams as a view of the requirements specification. This specification interface was integrated with the SPSA facility to allow other types of requirements to be specified, such as system structure, system dynamics, systems size, data structure, and data derivation. Other tools created as part of the environment included Mondrian, an automatic data flow diagram layout and display facility; CUBUS, a structured design support tool that generates structure charts for design specifications; and Tempro, an on-line, template-based editor for SPSL.

Some initial research was also conducted on the development of a metasystem for specification environments. A logical definition of an intended system development environment is input to the metasystem, which uses this information to generate the tools required to support the defined environment; including graphical interface, graphical layout and reporting capabilities. The database support for the Metaview metasystem has been developed and research is continuing on producing a complete metasystem that supports a wide range of specification development environments.

The DEVIEW system has been used in a number of analysis and design projects and tested in prototype form by SED Systems Ltd. It is available for distribution to both universities and industrial firms.

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Title of Project/Titre du projet: Professor

Simple sequence-based receiver structures for digital satellite communications

Digitally modulated signals transmitted via satellite channels are subject to significant distortion and hence performance degradation due to the bandlimiting effect of the filters in the transmission path and due to nonlinear distortion caused by the travelling wave tube amplifier in the satellite transponder. In the present work we have developed a simple robust receiver, for use with conventional digital modulations, that compensates for most of the distortion effects. The design of this receiver is based on applying average matched filter concepts to obtain a simple suboptimum receiver from the theoretically optimum Maximum Likelihood sequence detection receiver. The performance of this receiver has been evaluated through computer simulation. Design procedures have been evolved and the robustness of the resulting structure to variation in the level of nonlinear distortion has been demonstrated. Many of the results of this work have been published[1] and more detailed analysis is contained in a Ph.D. thesis[2].

In a second study, we have investigated the development of reduced complexity decoding algorithms for use with Ungerboeck encoded signals. These signals, which combine modulation and coding, can produce significantly better performance on a satellite channel than conventional signals; however, they require a complex receiver structure that is difficult to implement at high data rates. The intent of this very exploratory work is to find simple suboptimum receivers that are implementable at very high data rates. Although this work is far from complete, the following results have been obtained:

a) Ungerboeck codes suitable for use with a reduced complexity receiver have been found. These codes exhibit rapid growth in their distance properties as a function of time.

b) The architecture, but not the detailed algorithm, of a reduced complexity decoding algorithm has been determined. It is a hybrid between a classical sequential decoding algorithm and a projection-based variant of the more modern Viterbi Algorithm.

c) A generalized procedure for bounding the performance of any trellis code has been found. The resulting bounds are tighter than any which have previously been found.

Several publications and one Master's thesis have resulted from this work[3,4,5] and work is continuing.

---

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University/Université:
Phone number(Optional)/N° de téléphone (facultatif):
Title of Project/Titre du projet:

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Data Structuring for Page-Oriented Database Systems

Many collections of data are naturally organized into small units of text, possibly augmented by graphics. In such a system, each data fragment is independently maintained, but most of the fragments bear some relationship to other units. Examples include videotex, electronic billboards, electronic notepads, multimedia document systems, and computer-assisted learning packages. We refer to a unit of information as a *page* and a structured collection of pages as a *page-oriented database*.

Page-oriented databases are structurally dissimilar to conventional record-oriented databases. Because the information stored on an individual page is unconstrained, aggregation by type is not meaningful, and collections of related pages must be identified explicitly. A page-oriented database is thus a set of named sets of pages. In fact, the named sets are arbitrary, possibly overlapped, subsets of all pages in the database.

We have shown that querying the database corresponds to specifying the names of the subsets of pages to be retrieved. Traditional menu structures and keyword access systems correspond to specific naming conventions for, and possibly constraints on, the subsets maintained. Post-coordinate retrieval via boolean operations or QBE-like form-filling corresponds to extended naming conventions for subsets that are not explicitly identified and maintained in the database. Furthermore, preserving constructed sets and assigning them abbreviated names provides personalization that corresponds to materialized views in conventional record-oriented systems. Thus menu and keyword systems, with or without boolean or form-based query facilities, are merely special cases of a general page structure and general page manipulation facility.

Most importantly, we have demonstrated that user interfaces can be designed to support flexible, yet effective, access to page-oriented databases, and that such interfaces can support end-users of all skill-levels. Furthermore we have shown that any of the general or specific forms of page-oriented database architectures can be implemented efficiently in a stand-alone or distributed workstation environment.

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[10] *A Survey of Research in Computer-Based Menus*, Darrell R. Raymond, Technical Report CS-86-61

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[13] *A General System for Managing Videotex Information Structures*, David A. Tanguay, Technical Report CS-86-23 and M.Math thesis.

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(Check one/cocher la case appropriee)

☐ Biotechnology / Biotechnologie
☐ Food-Agriculture / Alimentation-Agriculture
☒ Communications and Computers / Telecommunications et informatique
☐ Industrial Materials and Processes / Materiaux et procedes industriels
☐ Energy / Énergie
☐ Oceans / Oceans
☐ Environmental Toxicology / Toxicologie de l'environnement
☐ Open / Ouvert

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Title of Project/Titre du projet: Modelling and Optimization of Hardware/Software Tradeoffs for Communications Protocols

High performance protocols for data communications are required for certain applications. They are important as a productivity aid for users of local networks, in manufacturing, engineering, education or the office; they are a product opportunity for companies providing communications products. This project attacked the problem of high performance (1) in executing high level protocols (transport and session in particular); (2) using special-purpose protocol processors (front-ends).

The project had the general goal to use analytic performance models to study the implementation of high-level data communications protocols in specialized processors or by specialized techniques, to improve the performance of the entire system. To do this, research was carried out on the effect of protocol execution workloads on system performance (that is, when is protocol execution important?); optimal allocation of work between a main processor and a special protocol processor, if one is provided; the breakdown of the workload of a high-level protocol (the ISO transport protocol); a method for analytic modelling of the interference between concurrent activities generated in executing the protocol; the value of a particular design principle called buffer cut-through, which avoids copying data between protocol layers.

Practical model-based methods for making decisions about protocol designs have been developed; knowledge about the protocols themselves has been obtained in the necessary form for use with the models. The buffer cut-through technique has been thoroughly studied and has been implemented for the ISO transport (class 2) and session (basic combined subset) layers; tests and performance measurements on this implementation will be available some time after the final project date.

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Further reports and papers are available from Prof. M. Woodside.

REGULATIONS GOVERNING THE USE OF GRANT FUNDS
(Excerpts from the 1986-87 Awards Guide) /

RÈGLEMENTS RÉGISSANT L'UTILISATION DES SUBVENTIONS
(extraits du Guide des subventions 1986-1987)

Description

86. Strategic grants are offered to individuals and groups to assist with the direct operating costs of research projects (including the organization of workshops and seminars) or with the purchase of equipment essential to the pursuit of research projects in the following areas:

- biotechnology
- communications and computers
- energy
- environmental toxicology
- food and agriculture
- industrial materials and processes
- oceans

In addition, through an "open" area, researchers may submit proposals in fields of national concern other than the seven designated areas.

Although individual applications are considered, group applications with a multifaceted approach are encouraged.

Strategic conference grants assist with the organization of conferences in areas of national concern.

Strategic Equipment Grants

104. Strategic equipment grants must only be used to purchase the equipment for which the grant was awarded. If recipients of strategic equipment grants do not require the full amount awarded for this purpose, they must refund the balance to NSERC. A researcher who is not able to purchase the equipment specified, or who wishes to select alternative equipment, must submit a written request to NSERC outlining the reasons for the change. The modified request will be assessed and the grantee will be informed of Council's decision.

NSERC expects beneficiaries of strategic equipment grants to make operating time available to other interested researchers whenever possible.

General Principles

205. Grant funds must be used effectively, economically, and in the best interest of the research supported by the grant. The financial administration of grants and the conditions governing their use are not intended to restrict grantees, but to ensure good accounting and administrative practices.

The administration of NSERC grants is carried out by three parties: the grantee, the university and NSERC.

- The grantee approves expenditures in accordance with NSERC regulations (outlined in the Awards Guide or imposed as a condition of a grant) and with university policies.
- The university administers the grant funds and establishes appropriate policies, controls and systems to ensure that NSERC policies and regulations are followed.
- NSERC defines the conditions under which grant funds may be used, monitors the use of grant funds, and interprets its rules and regulations for the university and grantees.

Description

86. Les subventions thématiques sont accordées à des chercheurs individuels ou à des groupes pour aider à couvrir les frais directs de leurs projets de recherche (y compris l'organisation de colloques et séminaires) ou à acheter des appareils de recherche nécessaires dans les domaines suivants:

- alimentation et agriculture
- biotechnologie
- énergie
- matériaux et procédés industriels
- océans
- télécommunications et informatique
- toxicologie de l'environnement.

Il existe également un thème «ouvert», dans le cadre duquel les chercheurs peuvent soumettre des propositions dans des domaines d'intérêt national autres que les sept thèmes choisis.

Même si les demandes individuelles sont acceptées, le CRSNG encourage les chercheurs à présenter des demandes de groupe à caractère pluridisciplinaire.

Les subventions thématiques pour conférences soutiennent l'organisation de conférences dans des domaines d'intérêt national.

Subventions thématiques d'appareillage

104. Les subventions thématiques d'appareillage ne doivent être utilisées que pour l'achat de l'appareillage pour lequel la subvention a été accordée. On doit retourner au CRSNG tout montant non utilisé à cette fin. Un chercheur qui ne peut acheter l'appareillage décrit dans la demande ou encore qui désire choisir un autre appareil doit faire une demande écrite au CRSNG, en donnant les raisons du changement. Le CRSNG étudiera la demande et informera le bénéficiaire de sa décision.

Le CRSNG s'attend à ce que les bénéficiaires de subvention thématique d'appareillage mettent du temps de fonctionnement de l'appareil à la disposition d'autres chercheurs intéressés, lorsque cela est possible.

Principes généraux

205. Les subventions doivent être utilisées de façon efficace et économique, de manière à favoriser le plus possible la recherche subventionnée. L'administration financière des subventions et les conditions régissant leur utilisation n'imposent au bénéficiaire qu'un minimum de restrictions, mais exigent de bonnes pratiques comptables et administratives.

Les subventions du CRSNG sont administrées par trois parties: le bénéficiaire, l'université et le CRSNG:

- le bénéficiaire approuve les dépenses en se conformant aux règlements du CRSNG (décrits dans le Guide des subventions ou imposés lors de l'octroi de la subvention) et aux politiques de l'université;
- l'université administre les fonds et établit les politiques, les contrôles et les systèmes nécessaires pour assurer le respect des politiques et règlements du CRSNG;
- le CRSNG définit les conditions régissant l'utilisation des fonds, contrôle l'utilisation des fonds et interprète ses règlements pour l'université et les bénéficiaires.

This chapter describes the financial administration of grant funds and outlines the regulations governing their use. Grantees who wish to use their grant funds to purchase resources or services not covered by explicit NSERC guidelines must consult their research grants officer or business officer, prior to committing any NSERC grant funds to such a purchase. If there is no explicit NSERC guideline to answer a question or no university policy covering the subject, the research grants officer or the business officer will seek an appropriate ruling from NSERC.

Ce chapitre décrit l'administration financière des subventions et les règlements en regissant l'utilisation. Le bénéficiaire qui désire utiliser ses fonds pour acheter des ressources ou des services non prévus dans les directives explicites du CRSNG doit consulter le responsable de la recherche ou du service des finances avant d'engager une part quelconque des fonds du CRSNG pour l'achat envisagé. Si les directives du CRSNG ne peuvent répondre à une question, ou s'il n'existe pas de politique universitaire à ce sujet, le responsable de la recherche ou du service des finances s'en remettra au CRSNG pour obtenir une décision appropriée.

Fiscal Period

212. NSERC grants are awarded to cover expenditures incurred during a specific period of time termed the fiscal period. The fiscal period for operating grants commences on April 1 of the year of the initial award and may be for one, two or three years. The fiscal period for strategic grants commences on November 1 of the year of the initial award and may be for one, two or three years. If not otherwise specified in published program descriptions or in direct correspondence with grantees, the fiscal period for other awards is one year from the date of the award (see paragraph 213). Upon receipt of a written request, NSERC may extend the fiscal time period of the grant if it is considered to be in the best interest of the research.

Période financière

212. Les subventions du CRSNG couvrent les dépenses engagées pendant une période désignée période comptable. La période comptable des subventions pour dépenses courantes débute le 1er avril et peut durer un, deux ou trois ans. La période comptable des subventions thématiques débute le 1er novembre de l'année où la subvention est accordée et peut durer un, deux ou trois ans. À moins d'indication contraire dans la description du programme ou dans les conditions d'octroi, la période comptable des autres subventions dure un an à compter de la date d'octroi (voir l'article 213). Sur réception d'une demande écrite, le CRSNG peut prolonger la période comptable d'une subvention s'il juge que c'est dans le meilleur intérêt de la recherche.

Commitments

215. NSERC receives funds for its programs through annual parliamentary appropriations. Thus, all commitments for support beyond the current fiscal year (e.g., second and third instalments of two- and three-year grants) are made subject to the availability of funds. Under no circumstances is NSERC able to accept responsibility for commitments incurred by grantees that exceed the actual funds to their credit in the NSERC Common Grant Account at the university.

Engagements

215. Le CRSNG reçoit du gouvernement des fonds pour ses programmes de subventions et bourses sous forme de crédits parlementaires annuels. Le CRSNG prend donc des engagements pour les années financières postérieures à l'année courante (p. ex. les deuxième et troisième versements de subventions de deux ou de trois ans) sous réserve de la disponibilité des fonds. Le CRSNG ne peut donc accepter aucune responsabilité à l'égard d'engagements financiers qui dépassent les fonds disponibles dans le compte commun des subventions à l'université.

Indirect or Overhead Costs

219. The funds provided through NSERC grants in aid of university research must not be used to contribute to the payment of indirect or overhead costs of research.

Frais indirects ou généraux

219. Les bénéficiaires ne doivent pas utiliser les fonds octroyés par le CRSNG dans le cadre de ses programmes de subventions pour payer des frais indirects ou généraux de recherche.

Payment of Salaries and Stipends

222. NSERC grantees may use their research grant funds to contribute towards the payment of salaries or stipends of qualified people working in their laboratories on a part-time or full-time basis. However, grant funds must not be used to pay any part of the salary or employee benefit plans of the grantee, members of the grantee's immediate family, other staff members of a Canadian university whose status would make them eligible to apply on their own behalf for NSERC grants, or recipients of other direct NSERC support. Grant funds must not be used to employ secretaries, but may be used to pay for typing services for manuscripts and reports.

Salaires et traitements

222. Les bénéficiaires de subvention du CRSNG peuvent utiliser leur subvention de recherche pour payer les salaires ou traitements de personnes qualifiées travaillant à temps complet ou partiel dans leurs laboratoires. Cependant, ils ne peuvent s'en servir pour payer une partie du salaire ou les avantages sociaux du bénéficiaire, des membres de sa famille immédiate, des membres du personnel d'une université admissibles aux subventions du CRSNG ou encore des bénéficiaires d'autre forme d'aide directe du CRSNG. Ils ne peuvent l'utiliser pour employer une secrétaire, mais peuvent s'en servir pour payer les services de dactylographie pour les manuscrits et les rapports.

Persons in one of the following three categories may be employed under a grant:

— assistants employed to help grantees carry out their research (research associates, research assistants, undergraduate students, programmers, technicians and other technical and non-professional assistants);
— postgraduate students and postdoctoral fellows receiving a stipend to work under the grantee's supervision or as collaborators to the grantee; such persons may not, however, be paid from infrastructure grants;
— visiting scientists receiving transportation, meal and accommodation expenses and stipends (if they are not themselves eligible to apply for NSERC grants) when invited by grantees to collaborate with them.

Les personnes appartenant à l'une ou l'autre des catégories suivantes peuvent être rémunérées à même une subvention:

— adjoints engagés pour aider le bénéficiaire à réaliser son projet (attachés, adjoints de recherche, étudiants de 1er cycle, programmeurs, techniciens et autres adjoints techniques ou non professionnels);
— étudiants de 2e ou 3e cycle et stagiaires postdoctoraux recevant un traitement pour travailler sous la direction du bénéficiaire ou en collaboration avec lui; ces derniers ne peuvent toutefois pas être rémunérés à même une subvention d'infrastructure;
— scientifiques invités recevant des frais de déplacement, de repas et de logement et un traitement (s'ils ne sont pas eux-mêmes admissibles aux subventions du CRSNG) lorsqu'ils sont invités par le bénéficiaire à collaborer avec lui.

Summary of Salaries and Stipends from Grants

Assistants	
—subject to university policies	
Graduate students	
—per annum:	$10,560
—per month:	$ 880

Résumé des salaires et traitements payés à même les subventions

Adjoints	
—traitements assujettis aux politiques de l'université	
Étudiants (2e et 3e cycles)	
—par an:	10 560$
—par mois.	880$

Purchase of Equipment and Other Materiel

237. When purchasing equipment and materiel, grantees must follow university procedures related to purchasing. Grantees must explore the possibility of purchasing equipment manufactured in Canada. Refer to paragraph 249 concerning the purchase of powered vehicles.

Achat d'appareillage et de fournitures

237. L'acquisition d'appareillage et de fournitures doit respecter les politiques d'achat de l'université. Les bénéficiaires doivent étudier la possibilité d'acheter des appareils fabriqués au Canada. Consulter l'article 249 pour les règlements régissant l'achat de véhicules motorisés.

Ownership of Equipment and Other Materiel

238. All equipment and materiel (including specialized books and publications, small assets such as cameras, small calculators, binoculars, tents, skis, etc.) purchased with NSERC grant funds belong to the university and not to the individual grantee.

When a researcher is moving to another Canadian university and wishes to move equipment or other materiel purchased with NSERC grant funds, Council encourages the university to accede to such a request provided the equipment is not necessary for the research activities of other researchers at that university. Assets so moved will belong to the new university.

Propriété de l'appareillage et d'autres biens

238. Tout appareillage et autre matériel (y compris, les livres et publications spécialisés, appareils-photo, calculatrices, jumelles, tentes, skis, etc.), achetés grâce à une subvention du CRSNG appartiennent à l'université, et non au bénéficiaire.

Lorsqu'un chercheur déménage dans une autre université au Canada et qu'il désire apporter avec lui les appareils ou autres biens achetés avec l'aide financière du CRSNG, le Conseil encourage l'université à accéder à sa requête si les appareils ne sont pas nécessaires aux travaux d'autres chercheurs de l'université. Les biens ainsi déménagés appartiendront à la nouvelle université.

Computing Costs

241. Grant funds may be used towards payment of charges for machine time, programming services and other related expenses essential to the conduct of the research for which the grant was awarded.

Frais d'ordinateur

241. Les subventions du CRSNG peuvent servir à payer le temps-machine, les frais de programmation et autres frais connexes lorsque ces dépenses sont essentielles à la poursuite de la recherche pour laquelle la subvention a été accordée.

Patents

243. NSERC grantees are encouraged to seek patent protection for their inventions or developments, particularly in such a way that will benefit Canada. One method of accomplishing this is to consult with and use the services of Canadian Patents and Development Limited (CPDL). Many universities have an agreement with CPDL to achieve this end.

Publications

244. Grant funds may be used to purchase certain specialized publications not normally obtainable through the university library and that are essential to the research supported by Council. These may include special tables, catalogues of functions, published data, specialized journals and like material. Such publications belong to the university.

245. Grant funds may be used towards costs involved in the preparation of manuscripts, whether for articles in research journals or books, and towards the payment of page charges for publication in scientific journals. Grant funds must not, however, be used to pay for printing costs involved in the publication of a book.

246. Grantees are encouraged, whenever possible, to publish the results of their NSERC supported research in Canadian journals, including not only the Canadian Journals of Research published by the National Research Council, but other Canadian scientific and technical publications as well.

Acknowledgement of NSERC Support

247. In any publication arising from research supported by Council grants, acknowledgement of NSERC assistance is expected.

Travel Expenses

248. Grant funds may be used to pay transportation, accommodation and meal expenses incurred during brief trips away from the grantee's university when these are essential to the research funded through the grant. The expenses may be incurred by grantees or by persons working with or for the grantees. Such trips include field trips (e.g., to collect specimens or samples or to use facilities located elsewhere), trips to consult with colleagues and attendance at conferences, meetings, symposia, etc. Transportation to and from the location(s) of sabbatical leave and personal living expenses while at the place(s) of sabbatical leave are not allowable expenses from operating grants. However, field trips and conference travel during the period of sabbatical leave are allowable as specified above.

Research travel associated with leave in excess of three months is not normally considered a brief trip, but under certain circumstances may be supported through NSERC grants:

Brevets

243. Les bénéficiaires de subvention du CRSNG auraient avantage à protéger leurs inventions ou leurs découvertes, particulièrement de façon à en faire bénéficier le Canada. Ils peuvent, à cette fin, consulter la Société canadienne des brevets et d'exploitation Limitée (SCBE) et recourir à ses services. Plusieurs universités ont conclu à cet effet un accord avec cette société.

Publications

244. Les subventions peuvent être utilisées pour l'achat de publications spéciales, comme des tables de données, des catalogues de fonctions mathématiques, des revues spécialisées et autres renseignements du genre qui ne peuvent être obtenus dans les bibliothèques des universités et qui sont nécessaires à la bonne marche des travaux de recherche subventionnés par le Conseil. Ces publications appartiennent à l'université.

245. On peut se servir des subventions pour payer les frais engagés lors de la préparation des manuscrits, qu'il s'agisse d'articles dans des revues scientifiques ou de livres, et pour payer les frais de publication dans des revues scientifiques. On ne peut toutefois se servir de ces fonds pour payer les frais d'impression qu'entraîne la publication d'un livre.

246. On encourage les bénéficiaires de subventions à publier les résultats de leur recherche subventionnée par le CRSNG dans des journaux canadiens, si possible. Il peut s'agir non seulement des journaux canadiens de recherche publiés par le CNRC, mais aussi d'autres publications scientifiques et techniques canadiennes.

Mention de l'aide du CRSNG

247. Le CRSNG s'attend à ce que les bénéficiaires mentionnent l'aide reçue dans toute publication réalisée grâce à une subvention du Conseil.

Frais de déplacement

248. Les subventions du CRSNG peuvent servir à couvrir les frais de transport, de logement et de repas engagés lors de brefs voyages à l'extérieur de l'université, lorsque ces déplacements sont essentiels à la conduite des travaux de recherche subventionnés. Il peut s'agir des dépenses du bénéficiaire ou de ses adjoints. Ces déplacements incluent les voyages vers les lieux d'expérience (cueillette d'échantillons ou utilisation d'installations de recherche) et pour consulter des collègues ou assister à des conférences, congrès, symposiums, etc. Les frais de déplacement (aller retour) du chercheur vers le lieu de son congé sabbatique et ses frais personnels de séjour au cours de ce congé ne sont pas admissibles. Toutefois, les voyages effectués au cours de ce même congé, vers les lieux d'expérience ou pour assister à des conférences sont admissibles, tel qu'il est précisé ci-dessus.

Tout déplacement lié à des activités de recherche et effectué au cours d'un congé de plus de trois mois n'est normalement pas considéré comme un voyage de courte durée; toutefois, il est parfois possible, dans des circonstances spéciales, d'en assurer le financement à l'aide des subventions du CRSNG:

— To spend research leave outside Canada – candidates must apply through the international programs of NSERC.
— To spend research leave within Canada for 3-6 months – operating, strategic and university-industry grant recipients must apply to NSERC for permission to use research grant funds for transportation expenses only.
— To pursue an extended field trip or to visit a foreign facility in excess of 3 months – permission must be granted by NSERC in writing.

Claims for travel expenses chargeable against NSERC grants must conform to the standard procedures and policies of each grantee's university, and a university has the right not to authorize an expenditure proposed by the grantee if such an expenditure contravenes university policies and/or any NSERC regulations. See paragraph 211 for submission of travel claims.

Grant funds must not be used to reimburse any travel expenditures for members of the grantee's immediate family.

Powered Vehicles

249. Recipients of NSERC grants may purchase a powered vehicle when essential to the research funded through the grant. However, prior university approval is required. By approving the purchase, the university accepts responsibility to provide insurance and any licence required and to register the vehicle in the name of the university. Grantees may also use their grant funds to pay for the long-term lease or short-term rental of such vehicles essential to the research funded through the grant. Grantees who wish to lease a powered vehicle on a long-term basis require the prior authority of the university. This procedure is similar to that required for an outright purchase.

Costs of short-term rentals of vehicles will be recorded on travel claims with other expenses of the field trips, etc.

If powered vehicles purchased through the grant or leased on a long-term basis through the grant are kept at a location other than the university, grantees must be prepared to certify that the vehicle will be used for research purposes only.

Organization of Conferences and Workshops

250. Grant funds must not be used to cover the cost of holding a conference or symposium. Canadian university staff members wishing to obtain funds to support the costs of transportation, meal, and accommodation expenses of guest speakers should apply for a conference grant (see paragraphs 157 to 165). Strategic grant funds may be used for the organization of workshops, provided the request was included in the application. In addition, NSERC is prepared to provide funding for the organization of university-industry workshops (paragraphs 129 to 131) or of other workshops (paragraph 166). Regulations governing these new programs will be stated in the conditions of the award. Council does not have a program of support for attendance at conferences; however, operating grant funds may be used for this purpose (paragraph 248).

— En ce qui touche les congés liés à des activités de recherche à l'extérieur du Canada – les intéressés doivent présenter une demande dans le cadre des programmes internationaux du CRSNG.
— En ce qui touche les congés liés à des activités de recherche au Canada – les bénéficiaires de subventions pour dépenses courantes, de subventions thématiques et du programme conjoint universités-industrie doivent demander au CRSNG la permission d'utiliser leur subvention pour payer leurs frais de déplacement seulement.
— En ce qui touche la prolongation de plus de trois mois d'une visite vers les lieux d'expérience et à une installation à l'étranger, les bénéficiaires doivent en recevoir la permission écrite du CRSNG.

Les frais de déplacement imputables aux subventions du CRSNG doivent être conformes aux procédures et politiques courantes de l'université de chaque bénéficiaire; cette dernière peut refuser les dépenses proposées par le bénéficiaire si elles sont contraire à ses politiques ou aux règlements du CRSNG. Voir l'article 211 pour la présentation des demandes de frais de déplacement.

Les subventions du CRSNG ne doivent pas servir à payer les dépenses de voyage des membres de la famille immédiate du bénéficiaire.

Véhicules motorisés

249. Les bénéficiaires de subventions du CRSNG peuvent acheter un véhicule motorisé lorsque ce dernier est essentiel à la conduite des travaux de recherche subventionnés. Les bénéficiaires doivent cependant obtenir l'approbation de l'université avant d'acheter tout véhicule motorisé. En approuvant l'achat, l'université accepte de fournir les assurances et les permis nécessaires et d'enregistrer le véhicule à son nom. Les bénéficiaires peuvent également utiliser leurs subventions pour payer les frais de location à long terme ou à court terme de tels véhicules lorsqu'ils sont essentiels à la conduite des travaux de recherche subventionnés. Les bénéficiaires qui désirent louer un véhicule motorisé à long terme doivent obtenir l'autorisation préalable de l'université tout comme s'ils désiraient en faire l'achat pur et simple.

Les frais de location à court terme de véhicules seront indiqués sur les demandes de frais de déplacement avec les autres dépenses de voyage vers les lieux d'expérience, etc.

Si les véhicules motorisés achetés ou loués à long terme avec les subventions du CRSNG sont gardés ailleurs qu'à l'université, les bénéficiaires doivent être prêts à certifier que le véhicule servira exclusivement aux fins de la recherche.

Organisation de conférences et colloques

250. Il est interdit de se servir des subventions pour payer les frais d'organisation de conférences. Si un membre du corps enseignant d'une université canadienne désire obtenir des fonds pour payer les frais de déplacement, de repas et de logement de conférenciers invités, il doit demander une subvention pour conférences (voir les articles 157 à 165). On peut se servir des subventions de recherche thématique pour organiser un colloque, à condition d'en avoir fait la demande. De plus, le CRSNG est prêt à subventionner des colloques dans le cadre de son programme conjoint universités-industrie (articles 129 à 131) ou dans d'autres circonstances (article 166). Les règlements s'appliquant à ces nouveaux programmes seront énoncés dans les conditions d'octroi. Le CRSNG n'a pas de programme de subvention pour venir en aide aux chercheurs qui participent à des conférences; les subventions de recherche peuvent cependant être utilisées à cette fin (voir l'article 248).